ELEMENTARY SCIENCE EDUCATION

IN AMERICAN PUBLIC SCHOOLS

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PREFACE

This text in methods has been prepared primarily for use in teacher-training institutions as an aid in formulating a functional philosophy among young people who look forward to becoming effectively stimulating teachers of science materials in the public schools. It has further been developed for the guidance of teachers-in-service, principals, and supervisors who are interested in the furtherance of a comprehensive program of progressive science education in urban and rural systems throughout America.

The book is planned as a guide to the study of *methods of instruction* for the first eight grades; hence subject-matter content has been intentionally omitted, the author assuming content backgrounds in physical and biological science as supplied in previous or concurrent courses and reference textbooks. Leadership in the science phases of the whole curriculum is analyzed in some detail, with attention given to backgrounds applicable to the administrative organizations existing in various sections—the 8-1-3, 8-4, 6-3-3, and 6-4-4 plans being most common. Emphasis throughout is placed upon the interweaving of *all* science with *all* phases of the child's development, in and out of school. Reference to life-science content is the more frequent in developing child-science integration, for this phase lends itself more particularly to the functional curriculum of the primary-elementary schoolroom, as well as to child growth and development.

There is little of the prosaic or dogmatic within these pages. In discussing procedures for solving the various problem situations, a primary purpose has been to offer sound, helpful, practical counsel. When pedagogical theory clashes with the dictates of common sense and life experience, both the virtues and the faults of each are presented, with recommendations as to methods. A fundamental aim underlying

the over-all formulation presented is the development and fostering of a sound educational philosophy based upon organization of the science sequence on a graduated scale. Thus by building progressively upon previously acquired knowledge and skills, socialized activities will be fostered in the classroom through mutual interchange of ideas and experiences on a common level of pupil attainment.

Suggested nature games (as types), individual and group projects, and purposeful dramatic playlets which may be utilized as examples of "things to do" in enlivening science lessons in the primary and elementary grades are included, together with discussions of school and home gardens, pets and their care, nature trails, and elementary field excursions. Curricular outgrowth to include a world survey, methods of science activity unit development, departmental teaching of personal and community hygiene, and the broader concepts of "general science" are included, in terms of a typical 8-4 program, with 6-3 modifications in the junior high school. Culminating chapters include exemplary classroom experiments with plants, which have proved extremely useful in building concepts of observation and deduction on the basis of facts in all the upper elementary grades.

Part II is devoted to a listing of *Resource Aids*, including audio-visual sources of supply, a bibliography of publications in the field for teachers, bulletins and pamphlets obtainable free or at slight cost, classic nature pictures for use in the early childhood and lower elementary grades, agencies for the conservation of natural resources, dramatic playlets useful in elementary science education, elementary school songs about nature, graded science readers, selected phonograph recordings, and commercial sources of workbooks, materials, apparatus, and supplies—all of which provide the inexperienced teacher with a valuable series of informative and practically helpful supplementary science materials.

HARRINGTON WELLS

SANTA BARBARA, CAL.
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CONTENTS

PART I

THEORY AND PRACTICE

Chapter 1. THE NEED FOR CLASSROOM LEADERSHIP

Science education is but one phase of the development of the "whole personality."[1] The entire subject range of curricula within schools, extracurricular activities outside, and contacts in the community contribute to a cumulative process as each individual goes through life. As we undertake a comprehensive survey of the specialized problems of science education during the first eight grades of instruction, their relationship to the total lifetime curriculum must constantly be borne in mind.

Life is not entirely scientific, by any means, although the impact of recent discoveries and inventions in the scientific field has produced and will continue to produce repercussions in terms of social living in all parts of the world. Postwar development of jet-propelled planes, supersonic speeds, ultramicrosopic study, astronomical observatory equipment, radar, television, plasma preparation, sulfa drugs, penicillin, streptomycin, and atomic energy release cannot be longer ignored in our American classrooms. Modern living in a shrinking world implies careful consideration of social implications as regards science subject matter, social science-natural science integration and correlation forming foundation blocks for the supervisory superstructure in these fields. *Social awareness*, then, is a primary requisite for successfully vitalized science education in the world of tomorrow.

Science is a subject field which many pre-secondary teachers and administrators feel unqualified to handle in an

[1] Yancey, P. H., "Science and Education," *Bios*, Vol. XXI, No. 2, May, 1950.

adequate manner. The content material is factual, and the broad social picture is confusing as it fluctuates constantly with each new invention, improvement, and discovery. The ever-present possibility of being wrong on a question or point at issue sometimes creates an uneasy feeling of inferiority or professional incompetence. Pupils in an elementary classroom not infrequently know much more about the natural history of a polliwog or a tarantula than the teacher. Sometimes boys in the upper elementary grades know facts concerning internal combustion engines, aeronautical design, and radio mechanics which are perhaps more than a bit hazy in the minds of their schoolroom instructors, unless the latter have specialized in the particular branch of physical science concerned.

The wise elementary school teacher recognizes at once that this is no particular reflection upon his training, for no one human has learned all there is to know, even in any one highly specialized field of science. It is no disgrace to say "I do not know" in the classroom. It *is* disgraceful to try to *bluff one's way through a problem situation, only to become* enmeshed in obvious untruths. If a scientific matter comes up for discussion over which the teacher is unable to assume immediate mastery, he should express an earnest desire to learn the facts of the case involved, for his students as well as for himself. Such an attitude is not only respected by pupils and their parents, but tends to create a beehive of intelligent activity and research in cooperative undertaking, which is indeed a desirable end in itself.

A general indictment, however, of the teaching body at present in service is the frequency with which these unanswered questions arise in the American classroom. Definite lack of subject matter knowledge undoubtedly exists among a large number of pre-secondary teachers, even in states where professional standards are comparatively high. There are two avenues of remedial action available to teachers of elementary science materials: first, interest in, and attendance at, programs of in-service enlightenment and "refresher"

courses offered in convenient locations and at convenient times, such as summer sessions and locally supervised workshops. The second general point of attack is a carefully planned program of teacher training in our educational institutions, so that young outgoing instructors will be thoroughly equipped to deal with scientific problems related to social developments in a scientific age. Measures currently being taken and advocated for improvement in these directions will be discussed later in this chapter.

The supervisory assistance of a professional "big brother" would be of inestimable value to a great many teachers, already heavily loaded with forward-looking curricular problems in other fields of elementary education. Secondary science instructors in the biological and physical sciences have been trained as specialists in institutions of higher learning and are naturally better grounded in subject matter. All science teachers, however, may profit from comparative discussions as to method, content, and sequence. Professional science supervision is lacking altogether in many urban and in most rural systems. It is one thing for board members and district superintendents to blandly shrug the matter off with the statement that "supervision of the special subjects is being overdone." It is quite another matter when topics of pressing timeliness are glossed over or ignored entirely in our American classrooms because the great body of elementary and intermediate school teachers are not adequately informed.

Unprepared teachers and administrators faced with a necessity for modern science interpretation commonly set up "defense mechanisms" and rationalizations. This sort of "wishful thinking" might be ludicrous if it did not result in such educationally tragic repercussions. Grimly, teachers slide over what little science content is provided by outline courses of study, shifting pupil attention and interest *away from* science materials. The rationalization saturation point has been reached or is being reached in most schools, homes, and communities, however, partly because of recent stimu-

lation given to popular interest by current scientific developments. Relatively informed minds in science fields are numerically increasing *outside* the classrooms of our schools at a remarkable rate Magazines such as *Life*, *Time*, *Popular Mechanics*, *Popular Science*, *Science Digest*, *The Scientific Monthly*, and similar publications have made such information of prime interest to many home readers. The *Reader's Digest*, with its tremendous international circulation, frequently carries scientific summary material.[1] Parents read it, think about it, discuss it at the dinner table with their children; the children go to school next day and ask teacher about it!

A preliminary evaluation of mechanical facilities readily available for instruction is of value in considering any functional program of education. Physical plants, particularly in the elementary field, must be taken into account. City schools occasionally have a certain amount of well-worn equipment, such as magnifying glasses or perhaps a low-power microscope. Projectors are usually available. Very few elementary classrooms have gas outlets, but most have electric sockets. If there is no running water in the room, it is available in the corridor. Demonstration tables, aquaria, and display tables are always present in some form. Rural schools usually lack microscopes, gas, and sometimes electricity.

In spite of these basic and obvious facts, nationally published "workbooks" for teachers often include experiments requiring microscopes, slides, cover glasses, eye droppers, centigrade thermometers, pipettes, forceps, dissecting needles, beakers, and Bunsen burners for the successful completion of "elementary" science exercises. A fairly good hand telescope is quite essential for independent single and group observation or direct demonstration of many astronomical constellations, the study of which is recommended for the elementary grades by widely accepted science readers.

[1] See Fichter, George S., "Scientists and Science Writers," *American Scientist*, Vol. 38, No. 1, January, 1950.

It appears factual that graduating young professional people will hardly find in the locations in which they are assigned to give instruction in elementary science, the equipment they enjoyed using in normal school or teachers college. Subject matter, therefore, should be basically of a character which may readily be observed in the field and stream, on the highway or railroad right-of-way, in the home, in the air, or even in the schoolyard itself. Much classroom equipment is unnecessary, anyway. A great deal may be accomplished through wise utilization of modern books, audio-visual materials, and group field demonstration. As a matter of fact, acceptable functional elementary science laboratories are the sky on a clear night, the river bank, the lake shore or seashore at low tide, the open field, the forest, the marsh, the railroad station, the airport, the motion-picture theater, or even the easy chair beside the radio! These, in truth, are the basic demonstration laboratories of *life*.

The Teacher-training Problem

Science classes in our teacher-training institutions are currently being reorganized along lines more functional in character, in terms of graduate need. Professors of a type sympathetic with the aims of public school science instruction are being encouraged to change from the more formal laboratory courses to new survey curricula planned especially for use in educational institutions. There are still basic faults in the teacher-training program; in fact, new deficiencies are constantly appearing as our thinking progresses. Science instruction is subject to the usual interdepartmental attacks in our normal schools and teachers colleges; each department seeking more student time for its particular field. Such interdivisional rivalry is natural and healthy up to a certain point and should be welcomed by educators in such a spirit. It is not difficult to demonstrate the long-term value of a thorough grounding in science education for teachers of young people in the public schools.

A national trend in institutions of higher learning toward

the furtherance of a *broad cultural education*[1] for all registered lower division students should cause no great disturbance among leaders of science education. The lowering of semester-unit requirements in specialized fields, including science, is again a challenge; for courses may be examined, revamped,

FIG 1. Science teacher training includes field trips to points of environmental interest, such as these ocean tide pools. (*Photograph by Sanchez.*)

and revitalized in terms of need, in order that such "units" as *are* taken will be eminently worth while. There are always elective subjects in such a liberalized college program, and if science subject matter courses are intelligently handled,

[1] See Cooper, Russell M., "The Rise of General Education," *NEA Journal*, Vol. 39, No. 1, January, 1950.

teachers-in-training will elect further work in this field of their own volition. In some teachers colleges today it is possible to *major* in science education for the elementary school.

One specific fault in American elementary teacher education must be cited: the fact that in some schools the student still has to "take" a certain number of quarter or semester units in science, but that *in some cases, at least*, these may be *any* science units in satisfaction of a blanket unit-number requirement. Transfers from other educational institutions where specialized preprofessional courses are not offered are often subjected to this functional handicap, as are students in the lower division bracket of our more ponderous universities, through no fault of their own. A transfer student who has perhaps "had" qualitative and quantitative analysis, together with organic chemistry, or who has thoroughly dissected double-injected frogs, sharks, turtles, and fetal pigs in a premedical-type zoology course, is not very well conditioned to the elementary unit-activity program! A young lady undergraduate may be exceptionally well grounded in plant morphology and may be able to glibly differentiate between the atypical and the typical orders of *Basidiomycetes;* she may even have received grades of straight A in "twelve or more semester units of natural science," *but she has no conception whatever of the real problems of primary-elementary science education*, as she will find out for herself in due time. This is the crux of the liberal arts-applied arts controversy, as applicable to the field of teacher training in elementary science.

Survey courses in the sciences should form the basis of every college curriculum. Whether the lower division administrative plan is termed "core," "fundamental," or "premajor," the salient features of physical and life science should be presented in truly foundational manner. Survey courses in *life science* should be just that: neither a compounded heterogeneity of physiological principles based on human biology or cellular biology alone, nor a listless examination of plant and

animal morphological types. *All* phases of *physical science* should be covered in the physical science survey course.

There has been, is, and will continue to be stiff opposition to the establishment of such lower division survey classes by opinionated persons of high academic rank, but the handwriting is on the wall. Sooner or later every important school in the nation will provide survey courses in the sciences for freshmen and sophomores, and teachers-in-training will be in the vanguard of students enrolled. Building upon this foundation, the superstructure of professional training in methods and philosophy of sequence and content in science education will functionally prepare for professional careers. It is this training and stimulation in methods and philosophy which this book is designed to provide in terms of practical application and psychological backgrounds.

The In-service Teacher-training Program

Teachers faced with the problem of relearning science subject matter in terms of professional use[1] usually attend summer schools or enroll in extension courses and workshops. Inauguration of a specific in-service science educational program has been of material assistance to many professional people. Round-table discussions, demonstrations, motion pictures, field walks, and child-observation groups are featured in many centers.[2] Nationally known field schools provide outdoor workshop classes, with a maximum of firsthand problem solving and a minimum of formal academic pressure. The enviable result of such tailored techniques has been motivated activity and a high degree of voluntary assimilation, coupled with a developed interest in and an appreciation of the role of science in modern living. The forgotten people of the educational world, *the teachers of America's children*, are now, at long last, beginning to receive the kind of in-service assistance they desire. Through summer and exten-

[1] See *National Elementary Principal*, Vol. XXIX, No. 4, February, 1950; also *Childhood Education*, Vol. XXVI, No. 7, March, 1950.

[2] See Lacy, Nan, "A Science Program—How It Grew," *NEA Journal*, V. 39, No. 4, April, 1950.

sion work teachers are learning to handle regional material in preparation for instruction of local children, integrating the specific environment with an expanded philosophy of national and international breadth of viewpoint.

An over-all leadership in science education is essential in our colleges and teacher-training institutions in order that such problems as have been outlined may be solved for the

FIG. 2. In-service teacher education. A group of elementary school teachers learn "firsthand" about soil testing in the field. (*U. S. Department of Agriculture.*)

mutual welfare of elementary education in America. Science education as a specialized field is currently recognized through the appointment of specialists in the U. S. Office of Education, coordinators in governmental agencies such as the Forest Service and the Soil Conservation Service, and professorships at many of our leading institutions of higher learning. Columbia, Cornell, Ohio State, Wisconsin, Colo-*rado, Stanford, Illinois, Oregon, Oregon State, Chicago, and* California at Santa Barbara are examples of university centers fostering integrative advancement in science educa-

tion. The socioeconomic law of demand and supply is inevitable in its operation.

Problems for Group Discussion and Review

1. Discuss the meaning of the term "whole personality."
2. What quality seems to be of primary importance in undertaking a program of science education in a democracy?
3. Just what should an elementary school teacher do, and how should he act, when pupils ask questions which he cannot readily answer?
4. Discuss the need for the legitimate functions of science supervision.
5. What qualities should be evident in the basic subject matter of elementary science in terms of availability and common interest?
6. Discuss the *teacher-training program* in science education. In what ways do you think college programs may be improved?
7. What are the advantages of lower division "survey" courses in the sciences, in terms of (*a*) students in general and (*b*) students interested in becoming efficient educators?
8. In what ways may standard-type lower division college courses in the sciences prove to be actually harmful to students planning to be elementary school teachers?
9. What steps are being taken to improve the *in-service teacher-training program* in science education?
10. Do you believe a "stepped-up" program of leadership training in science education to be justified by current world events and trends?

Chapter 2. TRENDS AND METHODS

Teaching is a science as well as an art. Application of the scientific method to educational problems has wrought a great many changes in the theory and practice of classroom instruction during recent years. As teachers observe the operation of this metamorphosis, and apply the knowledge gleaned therefrom toward the attainment of a degree of perfection in method, their general educational efficiency proportionately improves. The search for "a better way" tends to further the achievement of a better way. It follows naturally that, as classroom techniques become more scientific in the elementary grades, results should keep pace.

It may be well at the outset to clarify the conception of what is meant by "scientific method," which is certainly as applicable to elementary educational problems as it is to the rigidly disciplined fields of pure research. Procedure as generally accepted resolves itself into six steps:

1. A survey of the general field, noting major units.
2. Formulation of the specific problem, followed by orientation of the problem in terms of the general field of investigation.
3. Evaluation of contributory material and sources of information.
4. Experimentation. In the larger sense, the pursuit of new knowledge, recapitulation of old knowledge, and accumulation of data.
5. Summarizing the results obtained from procedure followed in step 4. Comparison of results with known results in similar fields and with *controls*.

6. Formulation of conclusion or conclusions, based upon steps 1 to 5.

Nowhere in the general field of education is this method more applicable than to the teaching of elementary science; yet paradoxically, in perhaps no phase of the total learning process has less attention been given to following it. As students of science education we preach the virtues of scientific procedure to others; should we not practice it ourselves? Should we waste our strength in petty disagreement or sit smugly in complacent self-esteem while our educational coworkers outplay us at our own game? If there is any criticism which can be justly leveled at graduated science teachers as a group, it is that we are professionally too self-centered. While other professional educators plan experiments and measure results, we sometimes blandly assure ourselves that "we know the subject matter, and that's all that counts, anyway." Many of us science teachers show a decided tendency to seal ourselves up in our classroom laboratories and "let the rest of the world go by." With disconcerting frequency, moreover, the world *does* go by, leaving habit-bound instructors to expound their dogma to nodding heads and empty seats. Is it not so?

Experiment and Evaluation

Wake up, teacher! Try anything—once. If it doesn't work, try something else. Trial and error may be moss covered, but they still retain their basic effectiveness as means to a desired end. As experiment is the crux of the scientific method, so should it be the keynote of our professional attitude toward our work. The effective presentation of science subject matter to young people is mighty interesting business. Evaluate your teaching, ascertaining its good points and its faults. Some pupils seem to appreciate their science lessons more than others. Why not all? Do you ever take short field trips? How about your art work? Do you integrate rhythms and music sufficiently? Do the children have an

opportunity to do creative work in elementary science? Are there enough individual projects and experiments? Do you use motion pictures? Do you talk too much and listen not enough? Is your technical material up to date? Are you familiar with the more recent administrative thought concerning science education? Remember, the world does move. Let us here briefly summarize some of the administrative plans most applicable to elementary science instruction.

The Problem Method[1]

The nationwide acceptance and application of the problem method allows the organization of elementary science materials in terms of long-term objectives. The stress today, as it should be, is put on the basic principles of science rather than on detail. In working with young children, content knowledge must to a degree be a secondary objective, serving as foundation for and building toward a scientific attitude of mind. Students must learn at an early age to *apply* their learning to new situations and strange conditions. We must train our young students to think accurately and analytically, to reason from premise to conclusion on a factual basis. This *training in the scientific method* is a most important phase of the development of children's minds, for certainly habits of intellectual honesty thus acquired will remain through life.

Division of work into major and minor problems permits a broad concept of the issues involved, and elementary basic and supplementary readers themselves may well be organized into a progressive series of science *problems*. At present, a few texts for child use are organized in this manner, and more will doubtless follow. Thus the science period utilizes both reader and procedure in approaching experimental and research problems.

Let us guard, however, against so sugar-coating our content material that we lose sight of drill training in actual mastery. Good old-fashioned *drill* is still a part of good

[1] Note the use of the problem method throughout Chap. 11, Laboratory Experiments with Plants, with the experiment titles being phrased as "questions."

teaching, for "spare the rod and spoil the child" has its application here as elsewhere. Prevalent trends toward problem arrangement, project committees, or activity units need not sway us from requiring the "digging out" of content material. To this end, the author favors a modified problem or activity-unit method in planning class work. While the major and minor trends continue in pursuit of problems and projects, now and again one should say, in effect: "Children, here are facts (or skills) necessary for further advancement into this phase of our investigation. Let us buckle down and learn them!" A baseball pitcher would call this a "change of pace."

In following the problem method, care must be taken that the major problem is not lost sight of during investigation of minor divisions. We must guard against the pupil finding himself in the predicament of the botanical student who "couldn't see the forest because of the trees." Pauses for comprehensive reviews (often oral) are invaluable in that they give each pupil a broader comprehension of the path already traveled, as well as affording a view of that which lies ahead. In the classroom laboratory, each problem must be clearly stated and discussed at the outset; its importance and orientation in the whole becoming clear to all. After council and consideration of the angles of the particular case involved, a method of attack should be decided on which will coincide with other methods employed. In some cases, a perspective view of the major and minor problems involved will call for observation of single demonstrations, while others will be studied best through group projects or committee reports. Development of this respect for critically analytical *perspective* is an important technique in elementary science education.

The Activity Program

The activity program is a comparatively recent development and is particularly applicable to elementary schoolwork. Teachers as well as parents have long been well aware

of the distaste many children show for classroom studies under dictation. Demands on the part of administrators and supervisors that "the course of study" be applied rigorously and without interlude have been partly to blame for the psychological results which are so obvious. Young teachers lacking in individuality, graduated into a teaching body bent under the yoke of "line of least resistance" habit, early realized the futility of creative effort. Children did not seem to learn what was set before them with a zeal indicative of real interest. Many openly resentful pupils gravitated into actual discipline problems. Attendant discipline, applied by experts, produced little result other than increased dislike of both teacher and education generally.

Progressive thinkers in the field, realizing the unwholesomeness of such a compulsory attitude in the elementary classroom, have brought about a change of thought which has to a degree revolutionized science teaching procedures. Instead of dictating orders, classroom administration has taken on a form of psychological suggestion, arising in a large part from teacher-training studies in educational psychology. *Children are led, rather than driven.* Formative minds are encouraged to think and to reason, in the child-centered schoolroom of today. By reasoning, working, and producing for himself, the child's personal interest (the *only* key to positive assimilation) is aroused. Methods, results, and conclusions are developed by the children themselves under *guidance* of the teacher.

Formerly a dictator in a realm of cringing or sullen docility, the teacher suddenly finds herself considered as a helpful friend, a "wise owl" whose privilege it is to suggest laboratory procedure and possible sources of information, to aid in planning science activities and projects, and to share in the enjoyment of the fruits of industry and attainment. Discipline becomes practically unnecessary, for busy children are not bad children, as every mother knows. The staid, brittle school teacher becomes a counselor; the sordid, precise room of blackboards and seat rows metamorphoses itself

into a place of mutual fascination and enjoyment of learning.

While utilizing the mechanical development of skills through mastery, as described in a previous paragraph, the activity program injects *interest* into the schoolroom laboratory, with excellent psychological and sociological results.[1] Early attempts to institute the program admittedly allowed *too much* democratic freedom; the loudest voice often ruled the selection of unit topics and procedures, which were not always compatible with desired lines of progress! This inaccuracy in early development of underdisciplined "progressive education" was only to be expected in undertaking such a novel program by professional people, steeped in the older methods, who were unfamiliar and untrained in activity administration. Pupils did *not* learn arithmetic well; sometimes "fractions" or "decimals" were skipped altogether! Elementary graduates did *not* learn to spell grade word lists. Teacher-training institutions have taken up this slack throughout the country, however, and a considerable body of professional people now combine drill and mastery with projects and activities. It has, indeed, been found that "all play and no work makes Jack a dull boy," to paraphrase a familiar saying. The new curriculum is based upon interrelated social science and natural science activities, *motivating interest, while insisting upon standards.*

Standards

Under such a cooperative activity-problem regime, standards of attainment in elementary science must be set up by teacher, supervisor, and pupils as criteria of project worth. The children will ask themselves and each other:

1. Is this project within our ability? Can we do it?
2. Will it result in our learning new things we ought to know?
3. Does the project interest the majority of the class?
4. Can it be accomplished in the time we have available?
5. Is suitable reference material obtainable?

[1] See Justman, Dorothy E., "Science Can Be Fun," *The Science Teacher*, Vol. XVII, No. 2, April, 1950.

With these and similar standards in mind, teacher and students consider proposed units of work, not in wild confusion, but quietly and thoughtfully. Each child gives his reasons orally before the group as to why he considers this project or activity worthy of serious study by the class; training in thought, reasoning, and judgment being utilized from the start. Guided evaluation precedes a democratic voice vote.

The project selected, procedure planning, method suggestion, and committee selection follow. As a plan unfolds and interest develops, modifications or changes may be made upon the basis of intermittent oral evaluation by teacher and supervisors. These reviews aid in planning future steps. Meanwhile, the teacher notes the progress of each individual, taking mental or written note or making anecdotal record of progress in terms of basic skills and educational objectives for the grade.

Homework

In many school systems homework is in exceedingly bad favor at the present time, and it is quite probable that this pedagogical device will be discontinued to a large extent within a few years. Certain it is that science educators must carefully scrutinize assignments of this nature, not only to make certain that they will contribute to the material advancement of pupils, but further, that they are within the pupils' capacity for attainment. The employment of a modified activity-unit plan tends to eliminate blanket home assignments altogether, since each pupil, investigating his own research problem during his own afterschool time, works on an individual project, related to those of his classmates, but distinctly his own endeavor.

Individual or group reports on special topics are the present vogue in many urban and rural centers, the amount of material assigned for investigation and the frequency of presentation being governed by the nature of the science unit as well as by the intelligence quotients of the pupils concerned.

Standards must be definitely variable according to type of class, individuals, location of the school, and similar factors. Individualization of elementary research will contribute much toward elimination of the objectionable features of extra homework.

Supervised Study

This technique has many champions Its proponents hold that intelligent guidance of pupil assimilation can do much toward creating and maintaining a proper intellectual perspective in terms of genuine individual progression. Certainly home study, even when seriously undertaken, frequently hits snags which need careful unraveling to clear up dubious points. The absence at home of a suitable agent or source whereby the pupil may obtain this counsel leads either to the absorption of misinformation, an omission of the clouded material, or complete abandonment of all study for the evening. This process, frequently repeated, can only lead to distaste for schoolwork and a growing neglect of all study habits.

Supervised study, if it replaces homework to any great extent, has one basic fault, readily admitted by supervisors and experienced teachers alike. This is the tendency of harassed classroom teachers to use such a period for "catching up" on their multitudinous clerical jobs, such as reading papers, correcting seat work, completing attendance-register reports, etc., instead of utilizing class time for the actual supervision and assistance of pupils Properly organized and intelligently directed, however, elementary class supervised study may be made to produce handsome dividends. *Free-reading periods* are in themselves a form of supervised study, for it is here that many children formulate new ideas and become inspired to study further into such subjects as science. Teacher-pupil discussions frequently flame into intense enthusiasm from the sparks of interest thus kindled.

The Unit Plan

The "unit" idea provides for the grouping of subject matter into various divisions and subdivisions, which are

studied by the class as a unit or center of interest. Usually there are "major" and "minor" units of study for each grade of the elementary school, the minor divisions being supplementary to the larger or major topics. Social science and natural science units are most commonly in use throughout the country. Some teachers utilize both, or use one to supplement the other. In general current practice, social science units, such as the study of a state or a country, provide the integrating center about which minor units converge. For example, a forth-grade *major social science unit*, "Our State and Our Nation," would incorporate within its coverage several *natural science minor units*, such as "Transportation," "Weather and Climate," "Conservation of Our Natural Resources," "How Our Crops Are Produced," and similar unit topics, limited only by the time available and the science sequence advocated within the particular system concerned.[1]

The extent to which the unit plan is used, of course, depends to a large degree upon the educational philosophy of the teacher and his colleagues within the school and within the urban or rural system. In some instances, all schools follow the plan completely, according to the concepts of "progressive education." In others, only a part of the school day is set aside for work on the "unit." In some localities no progressive education is used at all, strict old-line teaching according to tried and true methods being respected and recommended.

In general, there are five stages in unit development, which should be listed here in the interests of completeness: first, *exploration*, the "sounding-out" process which determines previous experiences of pupils, correlating this experience with the development of motivation and interest in the unit to be studied; second, *presentation* by the teacher of the outline for study, and selection of committees for active pursuit of knowledge; third, *assimilation* and *experimentation*, individual study, group conferences, committee reports, and supervised study; fourth, *organization* and summing up of material, planning rhythms and dramatic playlets; fifth,

[1] See Chap. 8, Unit Development.

individual and group *recitation* and *presentation*. This last step usually takes the form of a "culmination," in which the pupils demonstrate singly or socially what they have learned and how they have learned it.

The Project Method[1]

Where the unit plan is not followed, the project method often takes its place. In fact, teachers who oppose too much progressive activity use this plan in its stead and have done so for a great many years. Essentially, the theory of group interest is the same as for unit activities, for the pursuit of committee and class "projects" employs the same underlying psychological motivations. Students are always interested in studies of this type, because of their evident practical applications. A cleanup campaign, a better health survey, or a "be kind to animals" week are examples.

Among many elementary projects developed by the author, a spirited crusade against the common cold seemed outstandingly successful. The project took the form of discussion during social science and science periods, committee surveys of home conditions, correction of poor personal hygienic habits, and the mimeographed publication of a little "Health Bulletin" (generally distributed throughout the school by the "publicity committee") featuring prevention of colds. Another teacher organized his class into a cooperative dramatic unit; writing, rehearsing, and presenting a playlet on colds and their prevention before the entire student body in the school auditorium. Administrative cooperation of the principal and various supervisiors, because of the nature of the project, was readily available, and all pupils in all classes were genuinely interested. Results were all that could be desired, many being reached through the zeal of a few. Projects in science are employable at all grade levels, and each teacher will select those best adapted for his own use.

[1] Refer to discussion and examples in Chap. 7, Science in the Upper Elementary Grades.

The Socialized Elementary Group

The author believes firmly in socialized science lessons, as anything and everything which will tend to relieve the strain of "I'm the teacher; you're the pupil" situation as it exists in some elementary classroom laboratories (and college classrooms) throughout America. The informality of the socialized group, attempting through relative ease of interrelationship to break down the bars separating instructor and pupils, is in itself a contributing factor toward a spirit of investigation and assimilation. Analytical group discussion, when properly controlled and directed, not only contrives to draw more students into active participation in class projects through sheer force of contact, but tends to arouse interest in the science unit being studied through presentation of topics of mutual import.

Socialization emphasizes the familiar educational principle: *learning by doing*. Young people who work together, criticize, help, and advise one another, evaluate materials and contributions in terms of use, and draw conclusions as a group upon the basis of accumulated criteria are undergoing the finest possible training in the scientific approach to life and living. As will be repeatedly emphasized throughout these discussions, elementary school pupils will learn only to the extent to which they are *interested*. They may go through the motions of learning; listening attentively, doing their seat work quietly, reporting dutifully, making board sketches, and working on wall charts with sober earnestness; but fail repeatedly and conclusively when examined during evaluation of scientific content mastery. Sometimes a teacher will spend fifteen minutes clarifying a given point, only to have pupils reveal, through answers to leading questions put to them later, an utter lack of comprehension of the very fact or principle so forcibly presented.

In effect, socialized procedure reverses what traditionally has been accepted as the normal relationship. Instead of answering questions based upon previous teacher presentations, during "question and answer" periods, pupils ask *each*

other questions concerning doubtful points in the science problem under consideration. The pupils themselves thus participate in open forum, just as their elders do in our democratic society. In conclusion, it may be well to point out that this method has been found to be particularly effective with groups difficult to handle by ordinary means. The "high I Q" group and the "wide-range" group are cases in point Discipline is not a problem to the teacher who enjoys mutually friendly relationship with his children. It is human nature to try to please those whom we like and who share our responsibilities, and socialized groups tend toward this mutual friendliness and understanding.

Difficulties in Administration

Threatening blocks to successful socialization of the elementary class group occur at once to careful students of educational method. Adequate coverage of subject matter, drill in mastery of fundamentals, approximate adherence to the city or county system course of study, and evaluation of science achievement through standardized tests are objectives which must be given weight. Classroom democracy may lead far afield, or lend overstress to minor facts and issues, thus drawing the attention of teacher and pupils from major goals for the grade level and community situation. It is here that the clever teacher of science will use utmost skill in directing thought into desired channels, guiding advancement along a general path leading toward realization of his objectives and aims, suggesting methods of approach through individual and group assignment of topics and problems for research, and in all possible ways making socialization democratically effective in his cross section of society.

In perhaps no other field of elementary education may the socialized program be more effectively put into practice than in the consideration of major and minor science units of study The subject matter is peculiarly fascinating and timely to pupils of all ages, and most young people take exceptional delight in studying things which have a ring of

truth about them. The younger pupils feel a kinship with other living things, plant and animal. Older students, already feeling the impact of social living in terms of science and invention, discuss, wonder, and learn with a personalized enthusiasm. Questions and unsolved problems arise at every turn, magazines, newspapers, motion pictures, television, radio, and even the "comic books" so assiduously perused by most of the current older elementary generation[1] being filled to overflowing with topics related to science education. How best to organize and direct this natural and healthful curiosity of youth, molding it into a morale-building force within and without the classroom, is a perennial issue with the progressive elementary teacher.

Conversation in the Classroom

In the preceding section the mutual "give and take" of socialized forum discussions between pupils during periods more or less formally set aside for conversation has been discussed. These periods which encourage oral participation will have an interesting effect upon supervised study time, for the teacher will find that greater quiet will prevail when quiet is desirable, because of the "letting off of steam" by intellectually exuberant boys and girls. Just as recess periods refresh the bodies and clear the heads of young people, so do conversation periods stimulate the intelligence. Informal conversation, if normally carried on, is helpful in relieving the strain of the day's work among children as among adults. During times devoted to various forms of physical accomplishment, such as crafts period, nature study period, or the making of a wall frieze during art class, allow your pupils to converse naturally in normal tones, for how else may they exchange ideas? Many elementary teachers seem to feel that

[1] For copies of "comic books" demonstrating informative use of this medium in science education, examine a copy of *Dr. Fraud Confesses*, published by the American Cancer Society, or *Adventures in Electricity*, published by the General Electric Company. Addresses will be found in Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters.

a deathlike stillness must prevail at all times within the confines of the schoolroom, presumably as a demonstration of authority and discipline. Does conversation detract from the child's ability to "finger paint," or to labor on the construction of a model dairy while the group is engaged in the study of milk production, for example? A busy workroom should fairly hum with pupils' talk of features pertaining to the unit Perhaps one child in a city schoolroom has recently moved from a farm and knows at firsthand about the problems of such construction. Let him show the others, and let them talk about it as long as time permits, because the talk is of a constructive nature. To quell this and similar contributions is to discourage spontaneity and genuine interest.

Grouping

Socialized teaching involving centralization of pupils interested in mutual topics, is facilitated through an intimate grouping of physical appurtenances to the unit. Arrangement of seats and desks in rigid soldierlike rows is not only passé, it is a definite hindrance to socialized activity. Arrange your classroom so that pupils may congregate together in work groups or form panels. If the seats in your classroom are immobile, plan a reorganization along modern lines, for nothing so "dates" an instructor as a classroom equipped and conducted along nineteenth-century standards. Suggestions for modernization of the elementary workroom will be found in Chap. 4, The Classroom Laboratory.

Oral Discussions and Reviews

When reviews are indicated as centers of interest overlap, group discussion and oral quizzes may well replace the more formal written tests occasionally, under conditions as nearly approximating informal conversation as possible. True-false, completion, multiple-choice, and even essay-type examinations truly have their place in any well-planned program of elementary school evaluation and diagnosis, but from the viewpoint of practical contribution to the total educational

process, *oral* discussions are without equal. Doubtful points may be cleared up as they arise in the minds of pupils, eliminating the widely acknowledged danger of perpetuating false ideas and misinformation in the minds of elementary children, a common criticism of true-false, multiple-choice, and completion-type reviews.

Proceeding along socialized lines, "quizzes" and "tests" become genuine reviews, covering a wide range of material to the benefit of all. Of course, it may be argued that if a pupil does not know the content subject matter sufficiently well to pass a written examination involving fundamental questions, he or she does not truly possess mastery and does not deserve to pass the grade. To which the author assents, in the case of a basic grade achievement test covering a large section of the term's study, with the reservation that the test be of approved type, standarized, reliable, and valid. Each instrument of measurement has its place in the well-rounded curriculum; and of them all, oral informality more nearly approaches *the usage of everyday life* after the elementary school has been left behind. The average graduate will read and discuss scientific matters far more often than he or she may be called upon to write about them.

Audio-Visual Education[1]

In science education, as elsewhere, an audio-visual education program is a definite aid to the motivation of pupil interest, broadening fields of activity and fostering voluntary research and assimilation. In practically all the larger cities and counties, as well as in many of our more progressive state systems of education, bureaus are maintained from which assistance in planning audio-visual aids may be obtained. Charts, dioramas, pictures, lantern slides, models, and motion pictures may be obtained from these sources free of charge, or at a nominal cost. Booking services are available for the renting of films. Much that will prove of lasting and

[1] See Part II, Resource Aids: Audio-Visual Sources of Supply.

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flowers, leaves, farming, and a host of allied topics are readily demonstrated in the field.

The Departmental Plan

Some upper elementary and intermediate school grades are organized upon what is known as the "departmental" plan. Here the science teacher is a specialist; the class moving to

FIG. 3. A field trip demonstration These elementary school children are viewing the effects of soil erosion. (*Soil Conservation Service*)

his room for instruction at a stated period each day. This plan works well in practice, as far as applicable to instructive technique, for the teacher, having become a master in his field, can give more authoritative instruction in the science phases of teaching units, carrying into his laboratory a broad insight into the scientific problems involved. A classroom teacher, who must try to know a little about a great many things, could hardly be expected to do as competent a job as a departmentalized specialist, for the "Jack of all trades"

stimulating value may be brought before your pupils, if proper and consistent use is made of such facilities.

After a correlative program of audio-visual education is decided upon, the first step is to procure a projector through cooperation of the principal and the business office. Second, operators must be obtained from a competent source, for the teacher himself should be free to supervise, maintain order, and to discuss salient points in the slides or films which are shown to the group. Such supervision will no doubt be needed, especially at first. In elementary school practice the principal usually assigns one teacher to the projection booth for demonstration training in manipulation, film splicing, etc., while requesting another to remain with the students in the school auditorium. Occasionally, there will be boys and girls who do not appreciate their good fortune and opportunity, and these are to be given special written assignments in the classroom while others learn visually. One such assignment is usually sufficient, the pupil returning to the group at the next film showing, exhibiting extreme docility! There is no getting away from the fact that children enjoy motion pictures and do not wish to miss them.

A third and important step is the securing of funds for rental and expressage, if such funds are not available in a department of audio-visual education already set up as an integral part of the functioning school system. The parent-teacher organization will doubtless respond to an appeal for money to further this worthy cause, raising funds through card parties, teas, or kindred functions. Parent as well as administrative approval and backing will not be difficult to secure, if the program is sound. There follows a program of audio-visual science subjects, timed so as to coincide with classroom or unit topics and attended by all pupils.

Visual education *in the field* is another phase of the science educational program which will be discussed and strongly advocated throughout these chapters. There is much to see and do within the environment immediately adjacent to every school. Transportation, weather, light and power,

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is as applicable here as elsewhere. This plan works very well indeed if there is a teacher in the school who has always been particularly interested in science education and who specialized in this phase of elementary training during undergraduate days.

If teaching is done on the departmental plan, best results will be obtained through group participation by the various instructors in a weekly conference, at which time integration and intercorrelation are discussed, so that the individual instructor does not overemphasize his specialty at the expense of over-all progression. The resulting work plans provide all the advantages of instruction by specialists, yet intercorrelate the work in such a way that pupils receive maximum benefit from all.

The "Nature Club"

As a final suggestion concerning methods, let us include a recommendation for an outdoor or "nature" club as an extracurricular activity for older pupils.[1] This is at once the easiest, the most popular, and the most productive of immediate interest of all the stimulants the progressive teacher can employ. Returns from such an organization will be rich and varied, not the least of which will be the gathering of specimens and ecological data for use in the classroom laboratory. Fostering home interest in the work of the school, the nature club also furthers the harmonious relationship between home, parents, school, teachers, and pupils which is so desirable from every point of view. Within the school, members of the nature club will see that the halls and rooms are supplied with flowers, special exhibits, and conservation posters, contributing toward the social and civic consciousness of teacher-pupil personnel while materially adding to the appearance of the physical plant.

The above suggestions as to organization and methods are

[1] *Audubon Junior Clubs* are proving extremely successful. For informative folder, write to the National Audubon Society, 1000 Fifth Ave., New York 28, N.Y.

presented because of their widespread adaptability to the specialized problem of science education in the elementary school. Procedures, sequence, and philosophies differ among educators, as among all professional people, and use of some of these will vary under differing environmental situations. Each plan, however, merits serious consideration as a possible path toward professional improvement.

Problems for Group Discussion and Review

1. What is meant by the "scientific method" in education?
2. List the advantages and disadvantages of supervised study in the upper elementary school grades.
3. What is meant by a "socialized classroom"? What do you think of this plan?
4. Which students benefit most through socialized discussions?
5. Show why the project method stimulates initiative among pupils.
6. Discuss the steps to be taken in inaugurating a program of audio-visual education.
7. Why is the "lecture method" considered unsuitable for elementary teaching?
8. Under what conditions would you permit pupil conversation in the schoolroom?
9. Why is oral review advocated for use in teaching science to children?
10. What would be the advantages of a "nature club" within the school?

Chapter 3. PHILOSOPHY AND ADMINISTRATIVE PATTERN

Elementary education, early in the century, paid little attention to science fundamentals beyond occasional weekly periods devoted to "nature study." The elementary school picture, particularly in rural systems, was presented many years ago:[1]

> Science and laboratories are synonyms to most students. The environment of the school has furnished the laboratory at our door for years, but we have closed the door. (I remember distinctly a little girl who attempted to watch an oriole, a bright orange bird to her, build a nest out on the end of the branch of an elm tree in a rural school yard, and how the door was shut and the little child reprimanded for not studying her spelling lesson. The "word studies" have been forgotten, the mistaken teacher forgiven, but the bird moving to and fro over the grey pocket can still be seen in memory.) Spelling was important, but science was taught in the laboratory at high school or in college.

With the passing years, elementary school science has assumed more of a place in the day's succession of studies, usually in the afternoon, when children need restful and creative activity. There was little orderly administrative sequence, however, until publication in 1932 of the *Thirty-first Yearbook* of the National Society for the Study of Education.[2]

[1] Crofoot, Bess L., *Physical Aspects of the Rural Environment—Natural Science and Agriculture*, Problems in Teacher Training, Vol. XII, Moore Printing Company, Newburgh, N.Y., 1938.

[2] National Society for the Study of Education, *A Program for Teaching Science*, Thirty-first Yearbook, Part 1, Public School Publishing Company, Bloomington, Ill., 1932.

This study, entitled "A Program for Teaching Science," laid emphasis upon sequential development for the first time. Later, collective action by the National Society[1] reaffirmed the philosophy, adding support to the rising tide of professional opinion throughout the nation.

Elementary school science may be, and in many cases still is, administered under the older "separate-subject" method of study. In this form, class work for the day is divided vertically into several "periods," somewhat in the following manner:

Arithmetic	Geography
Spelling	Art
Reading	Science
History	Music
Grammar	Rhythms
Penmanship	

Let it be written here and now for the record: the author has no objections whatever to this vertical pattern, if it is effectively carried out to its potential conclusions by a teacher who knows his business and who believes firmly in the effectiveness of the method. Wholesale condemnation of *any* teaching plan for the sole reason that it has been in use for a considerable length of time is both unsound and unethical.

A district superintendent, a science supervisor, or an elementary principal who finds a teacher doing a competent job by the tried and true subject-period method should *not* insist that the teacher change over to the "progressive" plan forthwith. In fact, a wise administrator will not even suggest it. There are a great many factors which must be taken into consideration in such cases, discussion of which it is not the province of this book to undertake. Confining consideration to science education, there are certain *basic aims and objectives* which are to be attained to greatest degree. These

[1] National Society for the Study of Education, *Science Education in American Schools*, Forty-first Yearbook, Part I, University of Chicago

aims, which will be restated again in these pages, are (1) *to foster functional understanding of scientific principles*, (2) *to develop some measure of skill in the use of the scientific method*, and (3) *to inculcate in pupils an attitude of respect for scientific research.*

It may be that the most effective approach to such ends is progressive socialization. The teacher sees changes all about him. His students will compete with those of others during periods of evaluation and achievement testing. If he is getting reasonably good results with intellectually comparable pupils, he may *sing* science lessons, or *act them out*, or *write them*, with as much or as little drill as many seem necessary for adequate *mastery*. Any teaching procedure that *works*, in terms of pupil comprehension and progress for the grade level, and which meets with the approval of the administrative staff concerned is entirely satisfactory to the author.

It has, however, been rather conclusively shown during the years since the adoption in most states of the unit-"activity program," that pupils do react most favorably when they are *interested* in what they are doing and that they *learn through the doing itself*. Much long-term benefit may be discerned through social intercourse, brought about by the committee work involved and the pupil leadership provided. Individual creative effort is not a new thing, pedagogically speaking, nor is it rigidly confined to "progressive" classrooms, but stimulation of such effort through personal sustained interest is always a basically notable factor.

The history of "progressive education" is familiar to most students.[1] At first, the "units" were developed without attention to coherent sequence, and too much informality in the classroom led to overemphasis upon the social factors and not enough upon drill in fundamentals. People in P.T.A. meetings began to squirm uneasily and to complain that their children labored physically upon various fascinating outdoor

[1] See McCreary, John K., "The Nature of Progressive Education," *Education*, Vol. 70, No. 5, January, 1950.

FIG. 4. The *General Sherman* tree, demonstrated to city elementary school children in the illustration below This *Sequoia gigantea*, the largest living thing on earth, is at least 3,600 years old and has a trunk diameter of 33 7 feet. The tree contains an estimated 600,000 board feet of lumber, enough to build seventy five-room houses. (*Photograph by the author.*)

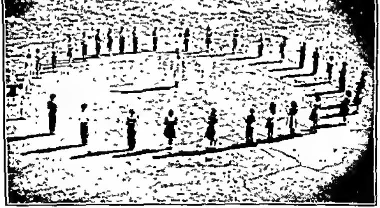

FIG. 5. "The biggest tree in the world is *this* big!" An interesting example of the doctrine, "We learn by doing" The young teacher has measured off 105 feet of string and has arranged the class in a circle on the school playground in order to show them the actual circumference of the giant *Sequoia*. (*Photograph by the author.*)

activities, such as erecting water dams to check soil erosion, all the school day, but that they were not mastering their basic arithmetic and spelling' This accusation, heard in parent-teacher gatherings throughout the country, had considerable merit in many cases. The author has personally contacted students in college teacher-training classes who, according to their own complaints, are paying the price in present difficulties in spelling, penmanship, and simple arithmetical problems for many former happy elementary school weeks and months spent almost exclusively in manual self-expression and actual physical work in the erection of demonstration check dams illustrating methods of soil and water conservation.

Modern interpretation of progressive theories concerning elementary teaching, however, shows at least parallel and usually superior development of skills. Drill, as has been stated, has its place today, and mastery is now required, while emphasis is placed upon social application of pupil investigations. It may indeed be said, from the viewpoint of science educators, that the progressive program, stressing research and debate, lays genuine foundation for a scientific attitude in meeting life's problems. Units, furthermore, are no longer adopted for grade study upon the basis of a teacher's summer vacation, perhaps spent in travel along the "inside passage" to Alaska, or to and from the beaches of the Hawaiian Islands! Nor do childish whims and blatant shouts now dictate what subjects shall be studied. Progressive education is here to stay, modified to suit personalities and situations, as elementary school pupils *live* life while preparing *for* it.

Correlation of separate subjects (running them in parallel paths) was an administrative fad for a time in our American schools. It was succeeded by the idea of *integration* or fusion, where teaching was worked into a common whole in terms of the child as a human animal, a living entity. This concept has definite merit psychologically and sociologically and is currently practiced in our better schools. Integration of subjects

is illustrated in a later chapter devoted to demonstration of procedure along progressive lines.[1]

The *core curriculum* is a comparatively modern device which has slowly worked its way up through the grades, even into many of our colleges and universities. Here, attention is focused upon group guidance and group preparation for living in state and in nation, with university emphasis in most cases upon social science, the "great books" in English, and the natural sciences. In the large concept the core provides the basic foundational subject matter about which the entire curriculum is oriented, and is widely respected in elementary administrative circles.

Scope and *sequence* involve thinking of objectives in terms of social and scientific aims on the one hand, and grade continuity in attaining these related objectives on the other. It may be shown by the well-known chart form:

GRADE SEQUENCE

SUBJECT SCOPE

Sequence of science studies is a perennial modern problem, currently under investigation in teacher-training institutions as well as in the field, for many contemporary situations arise in connection with sequence and content coverage which challenge professional adequacy in terms of child preparation for life in a world society.[2]

[1] Chap. 8, Unit Development.

[2] Refer to Chap. 5, The Child-outgrowth Formulation.

Personal Development and Preparation for Life

In presenting a specific philosophy of science education, a fundamental preliminary must be a consideration of basic aims and objectives for education in general. In practice "on the firing line," it must be remembered, a list of such objectives would be drawn up by a teacher "committee of the whole," after a thoroughly democratic interchange of professional thought. As finally adopted, such philosophical objectives doubtless would appear in radically different form from any original list tentatively advanced by the superintendent of schools or by the science supervisor. The concept as presented in these pages, therefore, is in the form of a constructive suggestion by the author as a classroom teacher of science, just as it would be personally offered at an administrative staff or teacher committee meeting:

Desirable Qualities Which Should Be Developed, in Terms of a Well-rounded Program of Personal Development

1. *Social awareness*—Development of the following qualities:
   A cooperative spirit of helpfulness.
   Tolerance of other persons and their views.
   A sense of civic responsibility.
   Community loyalty.
   State pride.
   National patriotism.
   International respect.
2. *Personal integrity*—Individual encouragement of the following:
   Honesty of word and deed.
   Loyalty to cause and to superiors.
   Self-control and discipline.
   Trustworthiness.
   Morality.
3. *Scientific attitude*—Personal and group training in:
   Curiosity and inquiring tendency.
   Basing conclusions upon factual evidence.
   Reserving judgment until all facts are known.

Logical thinking and clarity of concept.
Neatness, orderliness, and sequence sense.

4. *Physical and mental health*—Furtherance of:
"A sound mind in a sound body."
Preavocational interests in science and in nature.
Attention to the general mental hygiene of the child.

FIG. 6. Developing *social awareness* in third grade children. "A cooperative spirit of helpfulness" and "a sense of civic responsibility" become more than pedagogical phrases when science educators translate theory into practice. These future citizens are learning about the covering of pine needles, which might easily take fire and burn. (*U S Department of Agriculture.*)

5. *Personality*—Recognition and improvement of:
Personal appearance through child body grooming.
Visible good health through attention to good posture.
Neat personal habits and development of good taste.
English grammar and diction, within the limits of the grade.
Intellectual stability in each child.
A pleasant, friendly attitude. "The voice with the smile wins."

6 *Prevocational effectiveness*—Training in:
Content knowledge and skills for the grade.

- Manipulative experience for the grade
- Mastery of detail and technique, commensurate with development.
- Familiarity with elementary-grade literature in the field.
- A spirit of group leadership among elementary pupils.

Fields of Human Endeavor

Superimposed upon the desirable qualities related to personal development as presented above may be a group of *basic aims* related to *human interrelationships* and *economic intercourse* in a changing, chaotic modern world. Realization of personal human interrelationships and their importance in connection with economic intercourse is a basic broad aim of *all* elementary education. Fusion of such personal conduct ideals with *fields of human endeavor* in making a living, performing useful community service, voting wisely, helping others, promoting peace, and similar activities is another basic aim. These broad concepts will allow administrative leeway for complete individual teacher initiative and ingenuity in "cutting across fields" as each educator motivates science lessons at his grade level. Such units as "Conservation of Natural Resources," "Manufacturing," "Transportation," "Production of Foods," and "Science in Our World Today" are illustrative broad fields of human endeavor which demonstrate nationwide adaptability for integration in any science educational program.

Topics will vary considerably in stress and interpretation among various states, as well as between localities within certain areas of our larger states. This variation is logical and to be expected in view of the historical development and background of each area, the future plans for each community, the environmental control necessary, and the educational philosophies of teacher-supervisor groups considering the scope and sequence. The specific problems of New York City, for instance, differ in many respects from those of Phoenix, Arizona. To carry the analogy further, the local problems of Western elementary teachers are in many ways

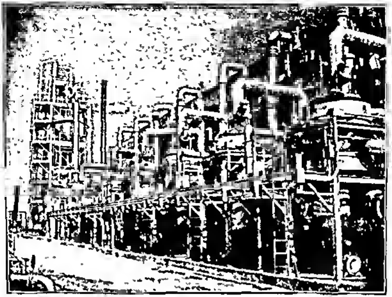

Fig. 7. Fields of human endeavor: *Manufacturing*. The technological skill of many scientists was employed in designing and building these distillation columns and converters of a phthalic anhydride chemical plant (*Courtesy of the Standard Oil Company of California*)

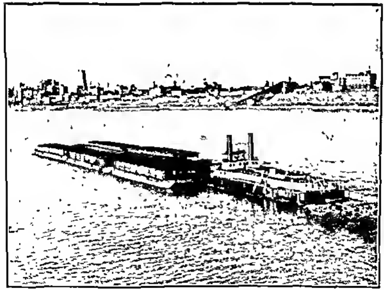

Fig. 8. Fields of human endeavor: *Transportation* by water on the Mississippi River below Memphis, Tennessee. Memphis is the world's largest cotton market.

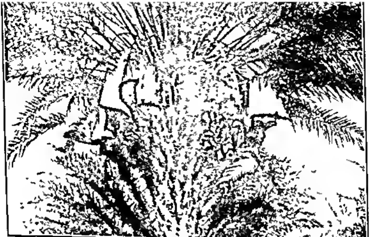

Fig 9. Fields of human endeavor: *Production of Foods.* On this commercial date palm, growing near Palm Springs, California, oiled paper bags keep birds and insects away from the ripening fruit and prevent excessive drying in the hot desert sun. Control of environment, a basic principle of science education, is seen in this area, formerly a wasteland but today an irrigated American Egypt. (*Photograph by the author.*)

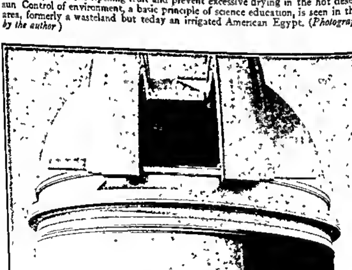

Fig 10. Fields of human endeavor. *Science in Our World Today.* The dome of Palomar Observatory, on the summit of Palomar Mountain in the clear, dust- and smoke-free air of inland Southern California. This structure houses the 200-inch mirror reflector telescope, the most powerful in the world. (*Photograph by the author.*)

quite different from those of educators along the Eastern Seaboard.

Aims of Child-Science Integration

Having stated some of the fundamental objectives of public elementary school administration, and having indicated the relative position of natural science in the broad elementary educational picture, it may now be pertinent to list exemplary "broad objectives" of *child-science* integration. Four *broad aims* are presented below, with *specific aims* elaborated upon for only the last of these, as an example. The method of elaboration is, of course, applicable to *all* the "broad aims," each of the them being divisible into a series of specific objectives. It will readily be understood that as specific aims are achieved, broad aims will concurrently be obtained. As these in turn are brought about, the "desirable qualities" of *personal development* (previously enumerated as items 1 to 6, inclusive) will be accomplished.

Broad aims of science education in public schools should:

a. Develop functional understanding of scientific principles, such as a realization of balance and interdependence in nature.

b. Emphasize the "scientific method" in obtaining and sifting evidence, leading to the basing of conclusions upon the basis of that evidence.

c. Inculcate an attitude of respect for natural laws, scientific truth, and research.

d. Develop in the field and in the classroom demonstrable methods of effective learning.

Specific aims, as has been indicated, may be elaborated upon from each of these broad aims. For example, the last broad aim (*d*) of *developing effective learning methods in the field and in the classroom* may be further isolated to include:

*d*1. Motivation and maturation of an ability to obtain good source materials for individual and group study.

*d*2. Training in competent laboratory procedure and factual accumulation.

*d*3. Stimulation of social participation in class projects and group activities, such as field trips, class seminar discussions, and similar socializing influences aiding in ultimate preparation for higher education and for life

The manner in which such "broad" and "specific" aims are actually worked out by teachers, principals, and supervisors

FIG 11. "Development of effective learning" through "training in competent laboratory procedure" in the elementary school. The young lady is arranging a specimen of marine alga, which she has personally collected in the field, preparatory to mounting and pressing for the permanent classroom collection. (*Photograph by by MacQuiddy*)

forms the substance of what are known professionally as "operational definitions." These, of course, include work in the classroom and in the field, together with accumulation of data on the things pupils do and say in and out of school. Methods of evaluating pupil behavior in terms of increased efficiency are constantly being revised as studies are made in

In conclusion, emphasis may be given the fact that such a science curriculum revision as is here set forth would never be truly finished. Changing facts and conceptions in the world of science, dominance and recession of wars and international "isms," and fluctuating economic conditions affecting social welfare in the community will suggest desirable changes, modifications, and adjustments throughout the years.

Problems for Group Discussion and Review

1. Discuss the elementary science situation prior to 1930.
2. What advantages and disadvantages does the vertical "subject" method have, as contrasted with the unit-activity plan?
3. What should the attitude of a science supervisor be toward the more formal separate-subject presentation by an older teacher skilled in its use?
4. Discuss the proper place of drill and mastery in the progressive program.
5. Compare and contrast "correlation" and "integration."
6. What has been the philosophy behind the development of a "core curriculum"?
7. Show, by an original chart diagram, how various elementary school subjects are integrated in the "scope" and "sequence" of the curriculum.
8. Present your own arguments for and against a sociovocational philosophy in the elementary school.
9. Outline some qualities you consider desirable as a foundation for pupils' later life in an American democracy.
10. Show how the qualities enumerated in problem 9 may be developed in a functional elementary school curriculum.
11. In what ways does elementary science education specifically contribute to the development of desirable qualities as expressed in analyses of topics 9 and 10?
12. Present some *broad aims* of science education.

13. Elaborate on any one of the broad aims mentioned in your reply to problem 12, developing *specific aims* in the process.
14. To what extent is teacher-administrative cooperation essential in science curriculum development?
15. What must the science supervisor do in inaugurating an extensive program of science education?

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here is opportunity for revelation and discovery. A few carefully chosen pictures will transform a barren expanse of schoolroom wall into colorful and stimulating background. Adding to these from time to time as projects develop, the teacher will soon be able to exchange new pictures for familiar ones as unit interests broaden, thus sustaining interest throughout the school term.

Freedom of Arrangement and Student Grouping

In other chapters the correlation of the science sequence with the unit school of primary-elementary education is discussed in detail. All who are familiar with this work realize the absolute inadequacy of the orthodox schoolroom, with its formal rows of seats and desks, as a physical plant unit conducive to individual and/or group expression. In the kindergarten and first grade its use in modern curriculum development is quite impossible. In fact, as we survey the situation, at no period in the educational career of the modern student, from kindergarten enrollment to the doctorate, are rows of fixed, screwed-down seats and desks preferable to movable chairs and tables. Even in high school and university, seating arrangements adaptable to grouping will facilitate student participation in seminars, supervised study, forums, panels, and other devices of democratic education.

Symmetrical seats facing the lecture platform are arranged basically for listening to the theories and observing the demonstrations of the *teacher;* the freer grouping is designed to further individual and group assimilation by *students.* Prim geometrical precision in the classroom laboratory of today should be replaced by equipment of usefulness in terms of functional design and mobility.

The occasional objection of noise during the confusion of pupils placing their physical equipment where they may best participate in the unit conference may readily be overcome by the fitting of tables and chairs with hard rubber or composition bases, obtainable as standard equipment or at slight extra cost. In the study of elementary science topics this

Chapter 4. THE ELEMENTARY CLASSROOM LABORATORY

Of the many factors bearing upon successful teaching, few exert a more powerful influence than the atmosphere pervading the schoolroom itself. The psychology of environment is no longer debatable. In the world of business, experiment has turned to custom; modern offices are clean, roomy, well lighted, heated, and ventilated. Factories are increasingly becoming centered in rural areas, among lawns, trees, and flowers. Recreational facilities, rest rooms, and clean working quarters are provided. In the world of entertainment, too, no feature is overlooked which will convey to the patron that sense of harmony and restfulness which is the foundation of a pleasant evening in the theater. Lobbies are subtly soundproofed, lights are soft and mellow, carpets are thick and quiet, usherettes and musicians are uniformly dressed, often to harmonize with the very photoplay presented on the screen.

Why this commercial struggle for effect? Why try to create atmosphere? In the world of dollars and cents, there is only one fundamental reason for doing anything. Because it pays! In increased output, lessened turnover of personnel, in increased patronage, these experiments in environment have been found to produce dividends.

The analogy is obvious. To instill in the minds of elementary pupils a genuine liking for their studies, a peace of mind and contentment of spirit which shall pave the way for voluntary assimilation of content knowledge, the classroom should appeal *to the subconscious.* Inspiration must be the keynote. Each pupil must feel, as he enters the room, that

It has been said that school teachers make excellent executives. Here is an opportunity for expressing your individuality through creative design and planning.

Planning Arrangement and Rearrangement of the Workroom

Planning the environment in which you wish your pupils to live and work is a fascinating as well as a fundamentally important phase of good teaching. Your pupils, if taken into your confidence, will be eager to share in this mutual adventure; but first you, as the teacher, must carefully study the problems involved. If radical changes are contemplated, they must be made during vacation periods when school is not in session, of course. What possibilities has your room? Do you have north light or southern exposure? Could space for group activities be created through the outright removal of three or four central rows of desks? This simple expedient has been followed by many teachers and superintendents with very good results in terms of improved group-project activities.

In the primary laboratory, workbenches are, of course, necessary and are doubtless present. Could not these be partitioned, or at least screened off to provide a junior factory for making nature-teaching aids such as stakes, little trellises, etc.? Some teachers prefer a long, movable worktable, at which many pupils work at one time. This may be given an added function, when not in service for crafts, of serving as a base for aquaria and other nature exhibits from time to time. It is heavy enough to remain solidly in place, yet it is movable if necessary. Space for a children's table should be provided. Here the teacher will place each day the materials and tools needed for that day's creative work, and from this the pupils may help themselves, choosing what they need.

If you plan the addition of new physical equipment to that already at hand, special attention to durability and size will prove wise. Other things being equal, purchasing agents will follow the recommendations of the classroom teachers in placing orders. Chairs and tables must be strongly

mobility is of particular advantage, since it lends itself to the interest grouping which is so characteristic.

Advice to the Beginning Teacher

Of course, beginning teachers will not always enter a classroom laboratory ideally arranged as to lighting, space, and mobility of equipment. In fact, about half of our elementary classrooms are still set up according to older standards. This is not a pleasant or in any sense an ideal situation; it is merely a fact. If you, as a recently certificated instructor, are assigned to such a room as we here condemn, what will you do? Certainly you must not complain to the principal or supervisor of its inadequacy for modern laboratory investigation. These people do not appreciate "whining" any more than you do in your students. Rather, resolve to demonstrate your adaptability and personal initiative by making the best of the existing situation, at least for the time being. Meanwhile, study the conditions, costs, and opinions of those about you, devising temporary adjustments and observing what older, more experienced educators have done and are doing under similar conditions. You may be surprised to learn that your principal and supervisor want those new physical conditions and equipment more than you do!

Suggestions to Experienced Teachers

Perhaps you are not a beginning teacher; rather the reverse. Must your room always look the same? Does your living room at home? Occasionally you rearrange the furniture, draperies, rugs, and vases there; why not try the idea at school? You already know the effect personal freshness and "snap" in clothes have on even very young children. The classroom laboratory itself must not be forgotten. Younger instructors look to you for guidance in this as well as in other professional factors which have influenced your success. Set an example of which you may be proud, rather than apologetic. An inviting workroom lends a real zest to teaching of all subjects, including topics related to science.

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made to endure well and should, of course, be designed as to height and width for use in particular grades by *left-handed as well as right-handed pupils.* Ask your speech supervisor about this! Variation in the physical size of individual pupils must also be taken into account, two or three sizes being available for those above the average or below. Comfort, we must remember, is as essential to little children as it is to adults, although less attention is paid to this fact than the subject merits.

In the lower grades, lockers must be provided which are large enough to furnish a storage place for bulky articles, such as building blocks. If we remove the formal rows of desks, we must supply a place at least as good, if not better, for boys and girls to keep things. Low filing shelves for finished work are appreciated by many teachers as a means of keeping children's work separated. Special science-demonstration apparatus of all types should be stored in the teacher's preparation room, away from the prying eyes and fingers of superinquisitive little people! A typewriter, featuring primer-size type, should be mentioned as being extremely helpful to the primary teacher. The Red Cross emergency kit should also be kept in the teacher's private room adjacent to the laboratory. Mimeograph machines and supplies are usually kept and operated from or near the office of the elementary school principal.

Nothing will help so much in planning the arrangement of a classroom laboratory for the use of small children as to actually *sit down on the floor* and survey the room from the eye level of the children who are to make use of it. Apparatus which may appear satisfactorily located from an adult's viewpoint often appears out of place when studied in this way.

The indoor laboratory should be large enough to permit the "acting out" of nature playlets as well as other dramatic presentations. A piano is essential for primary work, for nature songs are greatly enjoyed by little children and teach elementary science lessons in the process. A fountain, located

in a sunny part of the room, is a source of never-ending joy to kindergarten and first-grade children. If it is so constructed that an upper bowl contains plants and small animals such as water snails, goldfish, or guppies, nature observations may be made by little people while pure fun is being enjoyed. The lower basin will be given over to the children for their own use. All little people love to play in water, yet this enjoyment is usually forbidden. If the basin is made with an incurving edge so that water will not spill out, children may make free use of this laboratory property. Celluloid or plastic fish, boats, frogs, and rubber sponges cut to the shape of cats and dogs are examples of toys adaptable to the lower basin. Small aquaria are easily set up beside the water basins, furnishing a natural setting, together with ivy, ferns, and other indoor plants.

The *sand table* will afford further opportunities for science education in the lower elementary grades. Children love to gather about this property; it affords opportunity for enthusiastic, original, socializing play. Size and height of the sand table will depend upon the size and height of the children using it. The box should be zinc-lined with an incurving edge, which (as is the case with the water basin described previously) will prevent the sand from spilling out onto the classroom floor. Sand toys such as rabbits, turtles, lizards, road runners, burrowing owls, and cactus plants in miniature stimulate instruction via this pleasant medium. Used in connection with river bank or seashore minor science units, shells, stones, small birds' nests, tule, and other life may be represented on the sand table.

A *nature table* takes the place of the sand table in the higher grades, but it seems to lose none of its fascination for young people in the process. On and about this are arranged children's collections brought in from field and stream, objects of scientific interest, and various articles informative to workers in the classroom laboratory. Pupils frequently spend hours working at this table, fashioning animals from modeling clay, building rail fences from split twigs, and other

activities The nature table, or "science table" as it is sometimes called, is indispensable in the elementary laboratory of the modern school.

FIG. 12. Use of the "science table" in the classroom laboratory. These sixth grade girls are constructing a model astronomical observatory as an activity correlating with their study of the unit, "The Universe." (*Photograph by MacQuiddy.*)

Pictures on the Classroom Walls

In the elementary school laboratory, potted plants, bird mounts, aquaria, terraria, and colored photographic mounts are functionally useful as well as ornamental. The younger the children, the brighter the photographic illustrations, as is stressed elsewhere in this book.[1] Of course, all such classroom pictures will not be nature subjects, nor should they be; however, as we are here considering the classroom from the science education angle, natural science still pictures are emphasized. Most of all, children seem to appreciate those photographs which portray animal love and affection or

[1] Chap. 6, Nature Study in Early Childhood.

which express inner tranquillity through depth and space perception. Often they may be observed to stand for some time viewing such scenes in vicarious enjoyment and participation.

Frames are expensive, and storage space is often at a premium, nevertheless a very large number of individual prints are to be accumulated in order that these may be interchanged to correlate with unit subjects being studied during the term. To this end, mounts on heavy cardboard paper or "tagboard" are recommended by many experienced teachers. Others, however, find that just the pictures themselves, unmounted but kept in orderly picture files, are preferable. In this way color harmony may be obtained to coincide with any scheme, whereas if the still picture is permanently mounted, the background color is predetermined. Whichever method is used, teachers-in-training will be wise to begin early the systematic accumulation of stills, filing them under proper topic headings for future use.

Considerable thought and care should be exercised in making selections for semipermanent framed pictures for the children's laboratory, for what the teacher appreciates in art, they themselves will learn to admire. Such portrayals as Millet's *Feeding the Birds*, Baer's *Bird's Nest*, or Wiggins' *Down the Lane at Twilight* may be cited as examples.[1] By the ingenious employment of still pictures of many types, the most drab, colorless schoolroom may be transformed into an inviting communal workshop and a stimulating realm of investigation. All equipment, functionally direct and psychologically indirect, has utilization possibilities in the education of the whole child.

The Outdoor Laboratory as an Aid in Science Education

In the primary grades, if sand activities are carried on outside, a large sandbox is usually used instead of the nature table. A waterproof cover must be used for protection against

[1] Refer to Part II, Resource Aids: Classic Nature Art for the Primary-Elementary Classroom.

the elements and it should be placed in position each night upon the closing of the school play yard. Outdoors in the upper elementary grades, a birdbath may be constructed by the boys of the class, erected in such a position that the feathered visitors may be observed from within the classroom if the opportunity arises. Not only will observation opportunities come often, but especially if correlative feeding and housing projects are carried on, an ingrained love of small creatures will be established.

Gardening is always a popular activity with little elementary pupils, especially when they are allowed to have a little plot of land to tend for themselves. The outdoor laboratory will then include a garden, large or small. Not the least of the many lessons to be learned from this activity will be respect for the property and social rights of others. Equipment of the lower grade garden must be of a type which may be handled by little children: light yet serviceable. Small rakes with bamboo, wooden, or iron teeth, sturdy small shovels and spades, hoes with light but strong handles, trowels, small wheelbarrows that can carry reasonable amounts of dirt, and a watering pot or two complete the equipment ensemble. All these being small in relative size, the child uses them as he has seen grownups do, a psychological as well as a physical point worth considering. Stocks of hardy seeds will be provided, and their use supervised carefully by the teacher, for the small child does not like to fail. Indeed, he must not! Provide good soil and a little fertilizer, and see that the miniature productive garden is kept watered, and success in this lower grade activity will build for success in similar future undertakings as the child grows older.

What Are the Classroom Limits?

Realizing their influence upon pupils, we cannot take our elementary schoolrooms for granted. They, like people, cannot stand still. They remain dull and uninteresting semicells of a vast, dark prison called a "school," or they are meta-

morphosed into pulsing realms of child interest and enthusiasm through intelligent planning and consistent effort. It is not easy and simple to accomplish, this dream of a functionally ideal laboratory; on the contrary, it will take much work and trouble on your part to accomplish this end. But you will do it, at least to some degree, if you choose to do it. You will, if you are a real teacher, if you have the welfare of your boys and girls at heart.

A few words of caution and suggestion are in order. Do not use too much material. The best costume designers and interior decorators use very little, but they know that what they do employ is exactly suitable for the use to which it is put. Strive to create an impression of restfulness on the one hand, and of inspiration on the other. This may sound quite impossible, but if you will think for a moment you will understand what is meant. In nature, many such scenes stand throughout the years as examples of quiet, relaxing, yet uplifting and inspiring places. The panorama of Yosemite Valley from Glacier Point is such a place. Rocky Mountain National Park in Colorado, Boulder Dam, the Grand Canyon, the flowing Mississippi, Carlsbad Caverns, Mount Rainier, Mesa Verde National Park, and the view from New York's Empire State Building, as a metropolitan example, illustrate the point.

But what are the classroom limits? Are you actually bounded by four walls? What of the surrounding grounds? Even in a city, you are not far anywhere from a park, a zoo, an aquarium, or a museum. You can, (if you *think* you can) devise ways and means for including the surrounding area in your laboratory. You really should incorporate these areas in your thinking and cause them to be incorporated in the experience areas of your pupils, the future citizens of your community.

Possibly you could put across a science topic ideally in a spot not so far from your school, provided means of transportation were available. Do you think you could arrange for the use of a school bus for an hour or two, if you explained

the purpose of your request? In the larger cities, a telephone call to the superintendent of the surface transit company will nearly always result in reduced rates for the group excursion you have in mind. If you are not allowed to make such arrangements, your superior officers will make them for you. *Preliminary planning*, then, on the basis of physical and aesthetic possibilities (including the community and the surrounding environment) is the first and most necessary step in a program of classroom laboratory improvement.

Consultation with Superiors

No teacher should proceed independently in any such program without consulting with his administrative officers as to the advisability and the method of classroom expansion or limitations. Under no circumstances is it good policy, practically or ethically, to plan alone in such matters. If your plans are sound and financially possible, you may be assured of cooperation, for administrators frequently have valuable suggestions to offer, and always they view the undertaking with a *perspective* which the classroom teacher, through the very nature of his employment, possesses in limited degree. Your principal and your supervisor are primarily concerned with the improvement of teaching techniques in the school, and both are eager and anxious to help you in any and all projects which will further this objective.

A Child's Laboratory

When your own plans are crystallized and have been checked over with your principal and other "powers that be," the most pleasant step yet remains, the taking of the *children* into your confidence! You will not soon forget that school day! Let them suggest colors and arrangements. Do not spoil their pleasure by revealing too much, but, rather, lead them into the point of view already decided upon by your principal and yourself. General plans made, the children may actively aid in carrying out the multitudinous

details. Divide the work into planning committees, making each group responsible for certain phases which children might reasonably be expected to carry out. Remember, this is a *child's* laboratory that you are planning. Efficiency from your point of view, attractiveness from theirs. Bright colors appeal to children, and nature's green is one of them.

In cities particularly, children themselves feel the need of a greater familiarity with living plants and smaller animals. Space in the laboratory must be provided for the care and observation of these living things in or near the classroom. *Tradescantia* ("wandering Jew"), *Philodendron*, and *Hedera* (ivy) plants do extremely well indoors. Silkworms will thrive where mulberry trees are available and they make an ideal approach to the study of silk and textiles. In the immediate environment a birdbath or a birdhouse may be erected by the boys. A miniature museum may be created in any room from the kindergarten up, and if continued as a community project, may swell and evolve into considerable proportions and relative value. The "making-over" process is a worthy undertaking from many angles, and the net result is what you choose to make it.

Aesthetic Appeal Plus Efficiency

The author does not mean to emphasize change merely for the sake of change, although this in itself is not unprofitable sociologically and psychologically within the confines of an elementary schoolroom. Nor should beauty be brought about at the expense of efficiency. On the contrary, availability of materials and convenience of equipment and references are essential in science education. When Johnny asked you for a pencil last week, do you recall what you said to him about the "workman and his tools?" Teacher, have you *your* tools at hand? If Mary should suddenly indicate a desire to learn more about birds, for instance, than her elementary science reader tells her, what would you do? Discourage her promptly? Recommend a visit to the town library? Or could you at once point out the desired volume

on your personal reference shelf? Suppose Frank wants to know, "What is 'genetics', anyway?" Are you prepared for such an emergency? There should be a studied selection of such references in your library and kept in the classroom laboratory within sight and available to your pupils at all times.

Current magazines containing material of scientific interest should be subscribed to by the school and kept on a reading table A globe, a map of the state, a map of the nation, and a map of the city should be in evidence. Living and preserved specimens of plants and animals should be exhibited, not hidden away in closets and storerooms. In the lower grades, try setting up exhibits illustrative of "fairy tales" such as "Jack and the Beanstalk" using actual growing beans, with a tiny pupil-built house beneath a towering pole which may support the growing beanstalk. Smilax, small ferns, ivy, moss, and similar plantings in real earth mixed with peat moss complete the setting. Try doing such things as this *just once*, and you will do them always, for *pupil reaction is the criterion, and pupil reaction is immediate*. The wise teacher does not have to resort to declamatory tactics in describing the wonders of science in the world. His pupils have but to look around them to find illustrative examples in their immediate environment.

"This is all very nice," someone remarks, "but suppose an administrator walks into my room while I am immersed in all this striving for effect. What will *he* think?" Let me quote an assistant superintendent of one of the outstanding systems in the United States, discussing just such a room as yours is going to be:

> A classroom that looks as though its occupants tried to make it as pleasant a place as possible in which to work. A few bright, colored pictures, even though they were only magazine covers. A store of children's treasures in the form of collected material and work accomplished. Somehow it warms one on the dreariest day to step into a room in which the boys and girls live and work, and in which they take pride. Here is a class that takes pride in itself, in its teacher, in its room, and in its work.

Problems for Group Discussion and Review

1. What part does environment play in the teaching process?
2. Discuss physical student grouping as an aid to science education.
3. Why have orthodox rows of pupil desks fallen into disrepute?
4. Describe procedure in undertaking the rearrangement of a classroom laboratory.[1]
5. Why do we refer to the elementary schoolroom as a "laboratory"?
6. Describe equipment for the science education of very little children.
7. Describe equipment designed for use with older children in the upper grades.
8. What types of plants may be successfully grown indoors?
9. What types of animals might be successfully housed indoors?
10. Discuss teacher-administrator cooperation in laboratory planning.

[1] See Piltz, Albert, "A Science Laboratory for the Elementary School," *The Science Teacher*, Vol. XVIII, No. 4, October, 1951.

Chapter 5. THE CHILD-OUTGROWTH FORMULATION

Certain inherent difficulties in the classroom administration of elementary science readers prepared for nationwide use become apparent as the books are placed in the hands of children.[1] There is a tendency to use Eastern floral and faunal illustrations which may be unfamiliar in some parts of the country, which is only natural since the books have been prepared by Eastern authors primarily for consumption in the great population centers east of the Mississippi River, under climatic and other environmental conditions which differ radically from those of the South and Far West. Many children (the number runs into hundreds of thousands) have never seen a snowflake or a piece of coal in their lives!

Of course, such acquaintance material is excellent from the viewpoint of broadening education, but the reverse is also true: nationally circulated acquaintance materials should contain more information about the South and the West. This is admittedly a sectional view; it is nonetheless valid. Any investigation of population trends will reveal an astonishing westward movement which has been going on since the turn of the century and accentuated since the Second World War. California, for example, ranked twenty-first in population in 1900; in 1947 it ranked third, behind New York and Pennsylvania; and the 1950 census shows California in second place, displacing Pennsylvania from a position occupied by that state continuously since the year 1830. Information about Western conditions should be an integral

[1] See Mallinson, G. G., Sturm, H. E., and Patton, R. E., "The Reading Difficulty of Textbooks in Elementary Science," *The Elementary School Journal*, Vol L, No. 8, April, 1950.

part of science-reader scope and it doubtless will be more evident in the future than is currently the case.

Lack of social integration is another basic fault apparent in some elementary science texts. With conservation as an exception, social implications are often omitted and only science material presented on the theory that each elementary classroom teacher will integrate the science where and how he pleases. It may readily happen, therefore, that teachers may proceed with science-unit material to the almost total exclusion of social science factors, which is not the best type of presentation in terms of general education for life. Economic geography, interwoven with basic governmental patterns and the elements of "geopolitics," is in the opinion of the author the best integrating medium, and hence the most effective procedure in tending to bring about the orientation of our future citizens in a rapidly changing modern-world environment. Furthermore, the organization of elementary science books exclusively about core topics in science fields ignores a basic constant in educational psychology: *the child.*

The child lives in a private, egocentric universe known to him alone; everything he sees, hears, tastes, touches, and smells is oriented in his mind according to the ramifications of his own personal *orbit.* What a child makes a part of himself, out of a selective field of information, is strictly a matter of projection on his part, based on previous information and experiences.[1] Surely the child may be taught to show interest in other planets and constellations or to delve abruptly into the mysteries of plant and animal life of Japan, Mexico, or Hawaii, just as he may be taught to like olives or to fear snakes. But a little boy, as he hesitatingly stumbles through the portals of a Grade 1 classroom, is not interested in the "Rings of Saturn" or in "Prehistoric Life," no matter how logical such an approach may have seemed to those who prepared the "elementary" science reader for national distribution.

[1] Kounin, J. S., "Keeping Up-to-Date with Children," *Progressive Education,* Vol. 27, No. 3, January, 1950.

The child as a young human animal is truly interested in himself, his playmates, his little pet friends, his garden, and their welfare. To a limited extent, his orbit includes a world of wonderful newness outside his front gate and along the circuitous route to school. Essentially, he is interested in other living things, including children, and in *play*, which incorporates imaginative dramatization. Natural scientists tend to ignore these psychological constants in favor of subject matter, but there is a happy and effective middle ground, which will be found if we look for it. The role science education plays in the integrated development of each child in terms of maturation through social interrelationships and economic interdependence is shown graphically in the concentic chart on the next page.

A personalized philosophy of interpretation may be given at this point, prior to consideration and evaluation of the "formulation" by grades. As soon as the little child is able to walk, talk, observe, and think about what he hears, sees, tastes, feels, and smells, we should take him by the hand and walk about his home and garden. There we would pause to watch the kitten playing with the puppy, and if we were lucky, we might see a pretty butterfly entering the half-open petals of a flower. Next we would walk through the garden gate into the streets of the community. There we would find people like his father and mother, busy at their appointed tasks; the milkman, the mailman, the policeman, the groceryman, the fireman, the doctor, the teacher, the fisherman at the market. We would see and talk with other little girls and boys, too. Soon after this, the teacher should take the child on a longer walk into the surrounding country, or perhaps we might take a streetcar or bus ride to the river or to the beach, where we would walk along the shore and look down into the water.

Later, we would invite him, together with some of his little friends and classmates, on a hypothetical trip through the state in which they live. They would remember this wonderful trip all their lives. When they had developed sufficiently to travel farther, we would tour the United States with

them and visit other countries in this hemisphere. Perhaps we might even pick up a little Spanish for use in talking with our neighbors to the south. Later, we would travel around the world together. Finally, if we had exercised social and

FIG. 13 The *child-outgrowth formulation*, presenting natural science-social science integration throughout grade progression. (*Prepared by the author.*)

science leadership in our teaching, all these little people would be anxious to consider the theories and known facts about other worlds, suns, and the mysteries of life itself, together with such principles as energy conservation and basic natural laws. This is the essence of the *child-outgrowth formulation.*

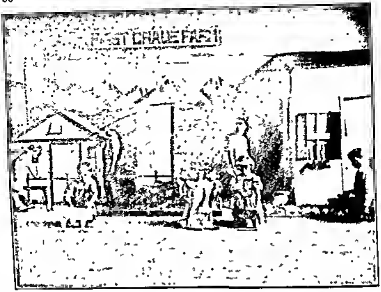

FIG. 14. *Grade 1: The Child and Home* With the assistance of an excellent teacher, these rural first grade children have constructed a house, barn, and silo at one end of their classroom and fashioned the farm animals so familiar to them. Lawn grass and wheat are actually growing in the soil flats. (*Photograph by the author.*)

KINDERGARTEN AND GRADE 1

The Child and Home

Health and Safety	Living with Others
Nature Games and Playlets	Pets and Their Care
Leaves and Flowers	Gardens and Gardening
Earth, Sky, Time	Music, Art, Rhythms
Reading	Writing

FIG. 15. *Grade 2: The Child and the Community.* Social intercourse, oral and written English, crafts, arithmetic, spelling, economic geography, and the sciences are correlated in such an activity as a "Second-grade Market." Interest motivation is obviously no problem in such a child-centered schoolroom. (*Photograph by the author.*)

GRADE 2

The Child and the Community

Groceryman	Water
Milkman	Gas
Garbage Man	Electricity
Postman	Lumber
Policeman	Glass
Fireman	Paper
Teacher	Metals

FIG. 16. *Grade 3: Environment* comes into the classroom. "Silkworms" have been found on the leaves of a mulberry tree. (*Photography by MacQuiddy.*)

GRADE 3

The Child and His Environment (the expanded community. The civic "county" closely resembles the area encompassed in this grade, yet the boundaries need not be definite.)

Soil and Farms	Early Indian Life
Livestock and Poultry	Early American Settlers
Air and Water	County Products
Light and Heat	The Farmer and His Work
Seashore and Mountains	The Fisherman and His Work

FIG. 17. *Grade 4: The Child and the State.* A California "native daughter" at the boundary of a state park. (*Photograph by the author.*)

GRADE 4

First Semester: *The Child and the State*
- Civic and Natural Boundaries
- State Parks and National Monuments
- Principal Cities: Reasons for Their Location
- City Parks, Zoos, Museums, Botanic Gardens
- Mountains, Rivers, Highways, Railroads
- Agricultural, Mineral, and Manufactured Products

FIG. 18. *Grade 4: The Child and the Nation.* A maple-sugar camp in the Vermont hills. (*Photograph by Derick*)

GRADE 4

Second Semester: *The Child and the Nation* (our national parks; conservation of natural resources)

East: Wood pulp; maple sugar; tannin; air, rail, and water transportation, manufacturing

Middle West: Grains, iron ore, beef, pork, lakes, rivers, all transportation

South: Tobacco, peanuts, cotton, oil, cattle, sulfur, cane sugar, yams, onions, sponges, prawns

West: Lumber, fish, mining, cattle, beet sugar, oil, citrus and other fruits, cotton

FIG. 19 *Grade 5: The Child and the World.* An Italian woman prepares wheat for grinding by hand. Wheat is the basis of tagliarini, spaghetti, and other pastes which Italians like very much. (*Photograph by Potter.*)

GRADE 5

Year's unit: *The Child and the World* (life in other lands)
- First Semester: *The Western Hemisphere*
  - Alaska through Argentina; Atlantic Ocean Area
- Second Semester: *The Eastern Hemisphere*
  - Europe, Africa, Western Asia, India and Pakistan, Mediterranean Area

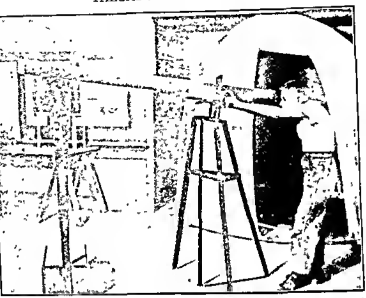

Fig. 20. *Grade 6: The Child and the Universe* This sixth grade boy has constructed a replica of the Palomar Observatory with the aid of his fellow committeemen and is demonstrating his conception of a scientist at work. (*Photograph by MacQuiddy.*)

Grade 6

- First Semester: *The Child and the World* (continued grade-sequence-integrated superunit)
  - Specialized Study of the Pacific Ocean Area (North and South America)
  - Pacific Islands: Philippines, Australia, New Zealand, South Seas, China, Japan, Siberia, Hawaii, Guam, Alaskan Coast, British Columbia, Chile, Peru, Panama, western Central American Countries, Mexico
- Second Semester: *The Child and the Universe* (broadened viewpoint aims)
  - Elements of Planetary Astronomy, Geology, Paleontology
  - Evolution of Plant and Animal Life
  - Energy Sources
  - Survey of Common American Plants and Animals
  - Survival of the Fittest
  - Education of Man to Fit Him for the Struggle for Economic and Social Survival

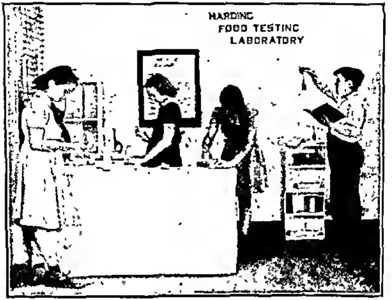

Fig. 21. *Grade 7: Personal and Community Health* These seventh grade students are demonstrating laboratory analysis methods of food study. (*Photograph by MacQuiddy.*)

Grade 7

Personal and Community Hygiene

- Rules for Healthful Living (given when most needed in terms of preparation for life)
- Effect upon Young People of Drugs, including Tobacco, Alcohol, and Narcotics
- Personal Health Habits
- Civic Cooperation in Betterment of Living Conditions and Conservation
- Extracurricular Activities
- Coordination of Science with Social Science in the Broadening Development of the Individual in Society

Fig. 22. *Grade 8: General Physical Science.* "Invention of machines for the betterment of man" is aptly illustrated by this film slitting machine, operated in an air-conditioned darkroom. (*Courtesy of the Eastman Kodak Company.*)

Grade 8

General Science (physical and environmental)

- Study of the Physical Environment of Young People
- Matter and Energy
- Interdependence of Living Things
- Environment from the Viewpoint of Chemistry and Physics
- Elements and Compounds, and Their Uses to Man
- Invention of Machines for the Betterment of Man
- Transportation (Automobile, Ocean Liner, Airplane)
- Modern Electronics
- An Over-all View of Physical Geography as Related to Human *Life on the Earth*
- Appreciation of Scientific Achievements and Research
- Emphasis upon Development of a Scientific Attitude of Mind

Elaborating upon this line of outgrowth-sequence development, illustrative, factual, background material is presented next, which has proved helpful in counseling teachers and practice teachers interested in elementary science education. Such a "superunit," broken down into major units in the various grades concerned, as illustrated in the topical outline presented in the previous pages, demonstrates the adaptability of natural science subjects as central nuclei about which entire curricula may be molded. The superunit plan is, in fact, but a part of *the child-outgrowth formation,* being correlated with it through the developmental sequence of the first five grades and carried over into the sixth as part of a world review and universe survey. The outline, progressively encompassing the child's expanding horizons, lends itself both in its entirety and in its individual major units, to the ten steps advocated in developing major and minor units, as shown in Chap. 8,.Unit Development.

The Home

Under the general heading "The Child and Community Life," two centers of interest are familiar in a child-centered curriculum: (1), the child's immediate family and the home in which he lives, and, (2) workers outside his home with whom he comes in contact in his daily life. Two minor units immediately present themselves: "Gardening" and "Pets and Their Cate." *Gardening* involves study of soils, use of tools, and choice of seeds. Children should be instructed in methods of planting, together with watering seeds and covering with burlap to shield the surface from strong sunlight. The teacher may demonstrate how the burlap may be raised as plants come up in the child's garden in order to provide shade for the seedlings. The various seasons may be studied in connection with gardening and general care of plants, for these topics go naturally together. In his gardening undertakings the child must be given every encouragement both at home and at school, through the providing of good soil, adequate water, proper tools, and strong seeds.

The study of *pets*[1] is a particularly good interest center for primary nature study, since nearly every child is quite interested in their care. Many pets are familiar in a general way to most children: canaries, cats, dogs, rabbits, chipmunks, squirrels, white mice, guinea pigs, silkmoth caterpillars, chickens, ducks, goldfish, guppies, lovebirds, parrots, pigeons, turtles, sheep, calves, and ponies serving as merely a partial list! Instruction in housing, care, and feeding of

FIG 23 Child love of *pets* is effectively demonstrated in this primary laboratory. (*Photograph by the author*)

these animal friends may well form a basic unit in the early elementary grades, as part of "The Child and the Home."

Motivation through the study of pets is easy, for all children know something of interest about at least some of the pets in connection with their own homes, stories which they are eager to relate to their classmates. These stories of the doings of animal companions form a desirable motivating

[1] Wells, Harrington, *Pets and Their Care*, California Science Guide for Elementary Schools, State Department of Education, Sacramento, 1934

agency for oral and written seat-work problems. Bookmaking interweaves art with English through cutting out in silhouette or coloring pictures of home pets. Clay modeling is usually productive of excellent results in the first two grades, and the completed animals may be publicly exhibited on the "nature table" or the "sand table," together with collections of miniature china, plastic, or metal animals. Collections of this type will provide material for projects studied in connection with workers outside the home, such as farming. "Peep shows" may be prepared by means of scissors, paper boxes, and crayons for the edification of classmates and parents, pets of various types being pictured in this manner. This activity is particularly good for rainy days. Poems composed by the children with their pets as subject topics, riddles, games, and plays comprise other suggested means of employing the pet theme within the elementary classroom. Phonograph recordings stimulate further interest, furnishing songs to which the small children may listen and providing music for creative expression.

Foremost of all pet activity is the school "Pet Show." Wherever such a show has been undertaken, the project has met with an unfailing success from the standpoint of pupil interest. Held in the classrooms, corridors, or schoolyard, the pet show provides opportunity for display of childhood pets and interests In fact, many experienced educators feel that even better results are obtained through combining the Pet Show with a "Hobby Show"; such childhood hobbies as airplanes, knot tying, matchbox collecting, dolls, and dozens of other hobbies being admitted along with the children's favorite home pets.

The Community

Studying further along the broadening topic, "Workers Outside the Home," two basic interest centers attract the attention of students. In our cities the grocery store which supplies vegetables, canned food, bread, and similar neces-

sities, the milkman who supplies milk, cheese, butter, and eggs, and the meat cutter who furnishes lamb, beef, and pork to the child's family all provide activity centers for research and inquiry for the lower grades. The duties of the garbage collector, gardener, nurseryman, museum, aquarium, or zoo caretakers are also prolific motivators in the field of science education. In the *country*, the work of farmers, dairymen, poultrymen, ranchers, lumbermen, animal breeders, county health officers, farm advisers, and foresters all provide interest centers. The work of the miner who brings natural wealth out of the ground (silver, gold, lead ore, coal) is another stimulating and strange field. All these "workers outside the home" may be utilized to dramatize and glamorize science lesson studies.

Holidays enjoyed or honored by the community in which the child lives form a further field for integration of science and nature materials. At Halloween, pumpkins, cats, bats, and corn may be employed, together with cornstalks and owls. On national Armistice Day, the poppy is sold on the public streets. Thanksgiving brings pumpkins, raisins, and turkeys; Christmas, the evergreen trees and holly berries. St. Patrick's Day brings the clover into prominence, while Easter is a day for little chicks, eggs, and "bunny rabbits." Arbor Day offers opportunity for the study of trees, along with the study of conservation of natural resources, while May Day brings the study of flowers into the elementary laboratory. In many centers, "Fair Day" (state, county, or local) offers special opportunity for group studies of community products.

Broadening the Child's Viewpoint

Science in the elementary grades closely parallels the social science curriculum, with special correlation afforded in geography and economics. In the fourth grade a study of local and state-wide plant and animal distribution may be undertaken, and characteristic flora and fauna made more familiar to the growing, intellectually minded young students. Lim-

iting factors, such as prevailing winds, climate, water supply, snowfall, forestation, and soil conditions will begin to be taken into account. Topography of the state and a preliminary knowledge of the general topography of the nation are subjects which may be introduced. Reserves for the national welfare, including timber, gold, silver, lead, and coal, are made clear for the first time. *Economics* as a point of view is new to the child, and a faint glimmer of comprehension indicates an awakening interest in social order and public good. Economic biology, emphasizing production of crops such as lettuce, sugar beets, melons, fruits, vegetables, corn, wheat, oats, and similar state products, is a fine field of emphasis from now on. Beef, pork, lamb, and their by-products, fish and fishing, forestry, and transportation of crops to market interest all children as they survey their state and nation.

A Survey of the World as an Integrated Grade-Sequence Super Unit

Continuing the social studies parallel, with emphasis upon economic geography and conservation of natural resources for the public good, pupils of the fifth grade may progress from a study of state and nation to a survey of the world. "Life in Other Lands" is a good fifth-grade unit title, indicative of pupil interest in social customs, people, foods, transportation, mineral and forest resources, weather and climate, and a host of interrelated topics in the field of social science-natural science correlation. Along lines developed in previous years, such studies may proceed to broaden the child's vision and intellectual scope until each grade carries him along the path smoothly from early home beginnings to a broadened concept of the entire world.

A survey of North America (Alaska, Canada, Newfoundland, Labrador, Mexico, and Central America, along with the West Indies) would logically precede a survey of South America which would emphasize such economically important hemispheric neighbors as Brazil, Argentina, Peru, Chile,

and Ecuador. The world survey superunit would continue in its broader implications as a first-semester, sixth-grade unit interest center, other countries being surveyed in a similar manner when Europe, Africa, Asia, Australia, and the Pacific islands are studied. A unified grade sequence is thus presented, providing a foundation upon which the superstructure of monthly, weekly, and daily activities may be developed. Such a world survey naturally and logically points the way to a culminating survey of "Other Worlds and Suns" in a final unit investigation in the field of planetary astronomy, at a time when the intellectual development of the young people has increased to a point where such concepts as "light years" may be handled with reasonable promise of effectiveness. As desired and as time permits, concepts of geology, paleontology, and evolution may be introduced into discussions at the discretion of teacher and administrators in each locality. The sequence is developmental, and the stage is set.

Modification of the child-outgrowth formulation as here presented will, of course, be the province of the local teaching body. It is anticipated that such variation, elaboration, and interpretation will be made as will prove most suitable to the specific teaching situation in each state, in each town, and in each school. Application of scope and progressive sequence thinking to the problems of science education will be fruitful in bringing about breadth of insight and educational development in terms of the child's comprehensive progression.

Problems for Group Discussion and Review

1. What constitutes proper criteria for establishment of content scope and sequence in nationally published elementary science readers?
2. Discuss the effect of geography upon science content in American schools.
3. To what extent do child growth and development affect breadth of elementary unit selection?

4. Discuss in some detail the philosophy underlying the *child-outgrowth* formulation.[1]
5. Diagram the salient features of the science sequence in each of the following cities along the Eastern Seaboard: Boston, New York, Philadelphia, Charleston, Atlanta, Miami.
6. Diagram the salient features of the science sequence in each of the following cities of the Central West and South: Chicago, Detroit, Duluth, St. Louis, Memphis, New Orleans, Houston, Albuquerque.
7. Diagram the salient features of the science sequence in each of the following mountain cities: Denver, Salt Lake City, Helena, Cheyenne, Boise.
8. Diagram the salient features of the science sequence in each of the following Pacific coastal cities: Seattle, Portland, San Francisco, Los Angeles.
9. How may holidays help teach science to children? Give examples.
10. Discuss in some detail your conception of "The Great World Survey" as an integrating, interlocking grade-sequence "superunit."

[1] See Davis, Hazel, "Elementary Science Possibilities for You," *The Science Teacher*, Vol. XVIII, No. 6, December, 1951.

Chapter 6. NATURE STUDY IN EARLY CHILDHOOD

Nature fascinates the very small school child. Inanimate objects, *of interest to* older pupils and to adults, take second place to living things; for little boys and girls seem to sense that these, like themselves, are *alive*, taking active parts in a world of breathing, eating, moving, feeling, smelling, and thinking beings. Even flowers and leaves share this appeal; perhaps the child realizes that these plant organs do not "think" in the strict sense; perhaps the child believes that they do. Certainly birds, cats, dogs, turtles, frogs, fish lizards, fawns, lambs, and other vertebrates, together with other children and "grownups," share this appeal life has to life. This is a basic tenet of science education in the years of early childhood.

Truth in Teaching

If a small child is left to choose a book from a varied group, he will usually select one profusely illustrated with plants and animals in striking color. Given a choice between pictures of places or events with which he is not familiar and pictures of such living subjects as dogs, cats, or rabbits, he invariably will choose the latter. It does not matter in the least to a child that the rabbit may have a silk hat on its head or that the cat is talking *with words* to the dog. College and university professors of the sciences worry a great deal about this "animistic" representation, and there is some degree of supercilious lip curling in departmental staff meetings when the subject of early childhood education

in science is discussed; which, it must be said in truth, is not very often.

What is the college student or graduate professionally interested in this field going to do about this problem?

FIG. 24 Child kinship with animate nature is a basic doctrine of science education in the years of early childhood. These young people are carefully examining a beneficial snake in the children's section of a zoo. Note the intense interest and the complete lack of fear. (*Photograph by the author.*)

Science demands *truth* and *fact*. Young children are interested in "fairy tales"! Can we strike a "happy medium"? Let us analyze this practical situation as it exists in our homes and in our primary classrooms. Kindergarten and first-grade children thrill to nature stories. "Goldilocks and the Three Bears," "Peter Rabbit," "Grandfather Toad," "Little Red

Riding Hood," and other fanciful tales capture the imaginations of young children to a remarkable degree. "Bambi," "Mickey Mouse," "Donald Duck," and a cocky little rabbit that chews carrots and greets human adversaries with a cheerful "What's up, Doc?" are well known to children of all ages, as a visit to the nearest motion-picture theater will readily demonstrate.

One of the most phenomenal records for continuous performance on the radio, coast to coast, has been that of the children's program Let's Pretend. Before any person, high or low in the collegiate academic scale, casts aspersions upon the employment of fairy tales in dealing with the precarious subject of child psychology, let him listen just once to this weekly CBS program and attentively check the child-audience response in the background. Bettet yet, let him unbend to the extent of inviting a few of the neighbor's young children in to listen! Let him watch the reactions and facial expressions, then let him consider the tremendous financial outlay involved. Why have sponsors fought to back this program for so many years?

The point is this: *Child psychology and child sociology indicate paths to the child subconscious* which pure science tends to ignore. As a college teachet of life science, the author is well aware of the objections advanced to any process leading to an acceptance by children of animistic explanations of scientific or other factual phenomena. Some supplementary readers in the primary field are filled from cover to cover with distortions of the talking-dog variety, or of plants and animals conferring together. Many child playlets are objected to on this basis, including some later to be presented in this book. Science knows that a canary cannot speak English. Therefore, science says that little children should be taught from the very beginning that such a thing is impossible; it is not so, there is no Santa Claus!

It is certainly true that nature encompasses more than enough of truth which is interesting and vital as foundational material, without the teacher resorting to the supernatural.

Riding Hood," and other fanciful tales capture the imaginations of young children to a remarkable degree. "Bambi," "Mickey Mouse," "Donald Duck," and a cocky little rabbit that chews carrots and greets human adversaries with a cheerful "What's up, Doc?" are well known to children of all ages, as a visit to the nearest motion-picture theater will readily demonstrate.

One of the most phenomenal records for continuous performance on the radio, coast to coast, has been that of the children's program Let's Pretend. Before any person, high or low in the collegiate academic scale, casts aspersions upon the employment of fairy tales in dealing with the precarious subject of child psychology, let him listen just once to this weekly CBS program and attentively check the child-audience response in the background. Better yet, let him unbend to the extent of inviting a few of the neighbor's young children in to listen! Let him watch the reactions and facial expressions, then let him consider the tremendous financial outlay involved. Why have sponsors fought to back this program for so many years?

The point is this: *Child psychology and child sociology indicate paths to the child subconscious* which pure science tends to ignore. As a college teacher of life science, the author is well aware of the objections advanced to any process leading to an acceptance by children of animistic explanations of scientific or other factual phenomena. Some supplementary readers in the primary field are filled from cover to cover with distortions of the talking-dog variety, or of plants and animals conferring together. Many child playlets are objected to on this basis, including some later to be presented in this book. Science knows that a canary cannot speak English. Therefore, science says that little children should be taught from the very beginning that such a thing is impossible; it is not so, there is no Santa Claus!

It is certainly true that nature encompasses more than enough of truth which is interesting and vital as foundational material, without the teacher resorting to the supernatural.

basic objectives may be accomplished during the school year and will consider approximately how much time and space should wisely be devoted to science subject elaboration, nature projects may be interwoven whether specific period time is allocated for them or not. These may be correlated with reading, art, social studies, handcrafts, and/or any other subject in the primary curriculum. In conducting a Valentine's Day lesson, for example, your art pupils may be requested to bring in some heart-shaped leaves. This may readily bring about quite a discussion on leaf form and color.

Dramatic Playlets

The "dramatic instinct" latent in every child is made much of at the present time in early childhood education. The group playlet provides an outlet for that strong desire noted in all humans, especially children, for the employment of gesture, motion, and voice in the "acting out" of events. There is a wealth of published material in this field which may be called upon, or original playlets may be devised in the primary laboratory from thoughts and materials contributed by teacher and pupils. Children participate in and watch such little performances with intense interest. Nature and health lessons may be adroitly put across the footlights in this manner, emphasizing worth-while points in a phase of pedagogy peculiarly adaptable to little children.

Let us warn at the outset against relative abuse of this medium. Perfect Thespians are much less to be desired than attainment of creative expression. Not infrequently the teacher becomes so imbued with a desire for excellence in dramatic production that too much emphasis is laid upon histrionic techniques and not enough upon *the lesson behind the playlet.* Presentations of the best type arise from the creative activities of the children themselves, knitted together into a cohesive unit by the instructor and speech supervisor. Indeed, the group dramatic playlet may well become the contributory outlet for all phases of activity in

"Knowing Our Animals"

An interesting variation of the above may be played with animals; the teacher beginning the game by announcing: "I am thinking of an animal with grey-colored fur, a little pointed face, sharp front teeth, big cheeks, small quick legs, and a long bushy tail!" Whoever raises his hand and correctly guesses "squirrel" may in turn think up an animal to describe. Observation of detail and broadening of knowledge is fostered through use of this game.

Plays

"A Garden"

Number of pupils: Twenty or more.
Presentation time: Ten minutes.

Scene I

A group of children are walking home from school. They talk excitedly about gardening and what fun it would be. Teacher has told them about seeds and how seeds grow into plants when planted and cared for. Each child, as he turns toward home, is planning to make a garden of his own.

Scene II

(Some time later. A garden.)

This garden has been neglected. Flowers and vegetables on the ground (represented by pupils) look faded and withered. The plants (pupils) droop their heads and bodies with sorrowful expressions, as if thirsty and wilted.

Other children come to play with the neglectful children who had planted this garden and then had not taken care of it Seeing the wilted, dying plants, they scold the bad children who had been "too busy" to water their garden. Realizing their faulty behavior, the children water the plants and cultivate around them with the help of all their friends.

Slowly the drooping plants raise their heads, straighten

the primary laboratory. Reading, manual creation, nature study, rhythms, music, art—all contribute to oral expression in preparation of such a socializing influence. Organized and conducted along such lines, the improvised or actual small stage becomes an integrating center for all early childhood education. Exemplary games and little plays will next be presented, each teaching a nature lesson and each serving as a type which the teacher may adapt for her own use. Games and dramatic playlets are firmly endorsed by leading educators in this specialized field and may be widely utilized in nature teaching.

Games and Plays as Aids in Primary Nature Teaching[1]

Games

"The Animal Game"

Teacher asks: "Who can walk and roar like a *bear*?" Receiving a demonstrative response, he next asks: "Who can strut and crow like a *rooster*?" The game continues until motivation is direct and response immediate from the children as they ask each other to imitate known animals. Observation is thus rewarded in some, while stimulated in others. All learn through group participation, in terms of social conduct as well as nature.

"Knowing Our Garden"

Teacher allows himself to be blindfolded by his pupils. The first pupil touches two flowers or plants in the room, or in the garden if the game is being played there. Teacher then tries to guess which flowers have been touched, using common names, of course. If teacher guesses even one flower, he may then choose the next to be blindfolded. Common names of garden flowers and plants which bear them are fixed in children's minds.

[1] Refer to the extensive grade list in *Part II, Resource Aids:* Dramatic Playlets Useful in Primary-Elementary Science Education. See also Leonard, Edith M., and Van Deman, Dorothy, *Say It and Play It*, Row, Peterson and Company, Evanston, Ill., 1950.

up, and smile for joy! Seeing this great change in their garden, the children resolve not to allow them to wilt again. With their many friends, they skip away laughing and happy. The garden plants, standing straight and tall, smile happily at the audience as the curtain falls.

Objective: This playlet emphasizes to very small children the necessity for constant daily care of their gardens at home as well as at school.

"Hunting"

Number of pupils: Twenty or more.
Presentation time: Fifteen minutes.

Two boys are on a "hunting trip" in the woods. (The trees are pupils.) The boy carrying the air gun remarks that he has killed birds many times and that he likes to see them die. The other boy, somewhat dubious, says that he has never been hunting, but hopes that he will enjoy it. Suddenly the boys see a flock of birds (pupils) among the trees. The boy with the gun shoots one of the birds, which falls writhing on the ground; the other birds run away screaming.

The two boys walk up to the dying bird. As they watch, it dies. The boy who shot it looks proud and arrogant as he struts about. The other boy looks very sad and finally begins to cry softly.

An old man appears. He has long white hair and a long white beard. He is a hermit who lives among the rocks, trees, and animals of the forest. The man asks the boys to be seated on the rocks, taking the sobbing boy on his lap in fatherly fashion. He tells both boys about the birds, how they like to live and love life just as little humans do, how beautiful they are, how sweetly they sing, how much good they do, what the world might be like without them, and speaks of the little baby birds that may be home in the nest.

By this time both boys are sobbing quietly, and the bloodthirsty boy feels very sorry for his act. The other boy comforts him, puts his arm around him, and tells him that he thinks he is a fine fellow. The old man shouts for joy, the

The classroom teacher later commented that his little charges discussed this talk for weeks afterward and that it had a decided affect on their behavior toward each other.

Contacts of such nature are memorable and stimulating to little children, and the teacher should never neglect an opportunity to bring them to his charges. Not long ago the author, a university teacher of science materials, received a unique communication, written in a painfully correct hand, inviting him to come to a school in a nearby city to view a collection of sea shells! The note was signed by forty-three little signature variations (some good, most bad) of what purported to be a second-grade class. The teacher's name or even the room number was not mentioned. Highly intrigued, the author hunted down the clues given and located the room and teacher a day or so later. Walking in, the visitor was confronted by dozens of broken specimens, placed at strategically located points of vantage in various parts of the room. After a few brief introductory words, the professor launched into a running ecological account of the animals represented by the shell fragments, followed by a brisk and businesslike question-answer period.

Out of the dozens of specimens, imagine with what surprise the author noted that these little "second graders" not only knew the common name and some of the habits of each animal, but excitedly volunteered information about the exact student who had brought in each shell and where it was found!

After the discussion and some time spent in viewing the individual prized nature collections of each pupil, departure was taken amid a clamorous chorus. Meeting the teacher some time afterward, the author expressed his pleasure, remarking that he had undoubtedly received much more than he had given in stimulation and thrill. To which the primary teacher replied, with a sparkle in her eye, that during the course of the impromptu nature lesson neither speaker nor children had noticed the blatant ringing of a bell indicating *a ten-minute recess!*

Primary Projects and Activities

The "nature table" mentioned in Chap. 4, The Classroom Laboratory, is exceedingly helpful in the primary grades. Children arrange tiny gardens parks, and even forests on a low table, each according to his own observations and experiences. Let each child bring his own materials and work on them in his own way, later requesting him to explain his

Fig 25 —Little "first graders" undertake a school-garden project. (*Photograph by MacQuiddy*)

ideas in a period of oral interchange and socializing development. *Gardening*, as has previously been indicated, fosters child interest in living things. Here plant growth, together with conditions favoring and hindering it, may be observed firsthand in the "outdoor laboratory." Special equipment adapted to pupil size has been advocated in discussing laboratory techniques, but best results from a psychological angle will be obtained if each child is not hampered

too much in the use of this equipment, but is allowed to learn through mutual intercourse with his friends. Supervision and extra watering must be done by the teacher when little gardeners are busily occupied elsewhere.

Teacher may well direct daily attention to the weather and its influence on both plants and garden. Relative amounts and intensity of sunlight, shade, and rain are basic bits of information which little children like to know. Examine what flowers are finally obtained together, inhaling the perfume, and discussing form and color. A realization of the importance of such factors in attracting insects as well as appealing to humans may readily result from this. The flowers may be drawn and colored during art lessons. Leaves, too, may be studied in this way. The uses of roots to the growing plant as well as for human food in some cases will be topics, and sometimes these discussions lead far afield.

Succulent leaves tenderly cared for by curly-headed seven-year-olds overnight develop ragged edges and are cut off at the stems. A search of damp leafy undergrowth beneath a rock nearby reveals the culprit snail. Its destructive nature explained, war is declared upon the garden pest, with later improvement in plants noted by eager little investigators. Perhaps weeds may come to the garden plot. Did the little girl plant them there? How did they arrive? Teacher need not go far afield to find illustrative examples and pupil motivation for a minor primary unit on "Seeds and Their Dispersal." Winged, hooked, and even explosive types will readily be found. Talk then with the children about the gathering and storing of seeds for food, as done by the Indians, lower vertebrates such as woodpeckers and squirrels, and by civilized man today. What foods eaten by children, such as breakfast cereal, are primarily obtained from seeds?

Germinate seeds indoors under artificial conditions, including an absence of light. Note resulting effects and consider possible use of new knowledge in planting the next

be made upon its construction, the furniture contained in the room, the apparatus used in the playground, and the toys and paper used by the children themselves, thus bringing home to each child the practical applications of tree growth to human welfare.

Primary school field trips should be undertaken with specific objectives in mind. Do not leave the school grounds "just to take the children into the open air," but formulate constructive objective aims in advance, discussing these with your pupils before the departure. In general, it may be indicated that visits to points related to units being studied are of greatest worth, the class visiting a dairy, a poultry farm, a plant nursery, a zoo, an aquarium, or other educational centers as available and correlated to the unit. Although written reports of such expeditions are not required, oral discussions may be held at considerable length, thus bringing home the significance of the visit. Field trips are as illuminating to small children as to older ones.

Bird Study[1]

Bird study is prolific of commendable results during the late primary period. The erection of a birdhouse or birdbath, mentioned in Chap. 4, provides interesting projects for the boys, who may help the teacher in construction of this community effort. Little girls of this age love to help feed the birds. As a stimulative introduction to bird study, the teacher may read one or more stories of the family life of birds, telling of the patience shown by bird fathers and mothers in selection of site, construction of nest, and care and feeding of the young, preparatory to teaching the little birds how to fly. Pupils may bring nests for study, which may be examined by the children and their construction noted. The teacher may point out how nests of different types are adapted to the needs of different kinds of birds and the places where

[1] Write the National Association of Audubon Societies. Address in Part II, Resource Aids.

they live. The study of nests, as a matter of fact, leads to a considerable discussion of plant-animal interdependence, if it is carried to its logical ends.

Molting interests all children, the changing of a drab, worn outer dress for a new one of brighter color resembling their own actions at home. Pictures of birds and their life habits may be employed to advantage, especially in teaching little children to learn the common names of some local birds which may be seen without difficulty by little children. Other class activities may consist of the cutting out of bird patterns and their coloring, modeling of nests and familiar birds in clay, the fitting together of sectional reproductions, and the putting up of bird transparencies on the windows of the primary classroom laboratory.

Insects

The study of common insects may well be included among late primary nature-period studies. Butterflies and moths beautiful in color and form, ants and bees in their ceaseless activity and social instincts, the song of cricket and honeybee, the jumping ability of the grasshopper, the many eyes of the fly, the fairylike wings of the dragonfly, and the web-spinning ability of the spider all fascinate young people. (The latter, though not strictly an insect, may be and probably should be considered with this group at this grade level. It is a bit too early to draw hard and fast taxonomic lines of distinction between insects and spiders, moths and butterflies, etc.) Under interesting class activities may be listed silkworm moth cultivation, ant-nest building and observation (children love to make these), cardboard, slate, and blackboard stencil making, field studies of insect homes, and beginning collections of insect types.

Harmful and disease-carrying insect forms are not to be stressed, many children of early-childhood age being highly sensitive to morbid influences. Teaching avoidance of the housefly and the flea as menaces to human health and wel-

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fare is sufficient in this regard. We must build for *appreciation* rather than fear of nature during this formative period.

Pets and Their Care

A most productive phase of nature work in the early primary grades, as we have previously indicated, is that dealing with childhood pets. Approach is easy and direct: encourage the children to speak of their home pets; how the kitten purrs, produces a thick coat of fur as winter approaches, how it can see in relative darkness, and similar topics. Dog stories of loyalty and heroism, together with general intelligence, are readily forthcoming. Motion pictures are obtainable showing St. Bernards and shepherds in action, as well as horses and ponies, which many children like very much. The holding of a "Pet Show" or a "Hobby Show" featuring children's pets has been mentioned in a previous chapter. Just one trial will convince the adult educator of the integrating potential latent in this device.

Suggested Primary Projects

Primary class projects take many forms as related to science education. The *song tree* is an interesting group endeavor supervised by the teacher, and one which correlates nature and music education nicely. At the beginning of the term the teacher cuts out a tree-trunk outline, which she pins or tacks to one of the pupil-level bulletin boards. As songs are learned, their names are printed on cards shaped and colored to resemble leaves, and these are added to the tree. Various shades of green, and even red or orange, may indicate different types of songs, as well as comparative difficulty or degree of excellence in rendition. As the class learns songs, the tree grows throughout the term!

Occasionally a setting hen is actually brought into the classroom laboratory, and committee care for the expectant mother arranged. Each child takes a personal interest in the situation and in the resultant baby chicks. Teachers who

have tried this project state that many desirable traits are developed in the process.

In addition to the "song tree" and the setting hen, a wide variety of individual, committee, and class projects may be successfully carried on during the primary grades. In the first grade, half an eggshell may be colored by a child, a bit of good soil placed inside, and a sturdy little seedling such as a "pot marigold" (*Calendula*) or nasturtium (*Tropaeolum*) planted in the soil. Perhaps a small carrot or beet may be "topped," and the cut section placed in a shallow dish of water. In a surprisingly short period of time bright new shoots will appear, to the delight of youthful botanists and of their proud parents upon whom the tokens of affection may be bestowed! Thick fleshy roots should be used, since these will better hold moisture during periods when the children forget to water them.

A young carrot, hollowed out after cutting the root transversely, then hung upside down so that the hollowed space holds water, will grow nicely; green foliage developing and turning upward from beneath in striking fashion. Yams or sweet potatoes make excellent room decorations, when budding tubers are set in jars of water and allowed to develop shoots. The yams have red stems and green leaves, growing beautifully in shaded classroom areas when constantly supplied with water in the jars. This project may last several months, becoming more interesting and beautiful every day.

Teaching on the Pacific Coast, the author has occasionally suggested the use of redwood "burls" to young teachers and frequently has one on his own desk. Beautiful young green sprouts are produced when a selected bit of *Sequoia sempervirens* bark is set in a shallow container of water. The growing burl will usually last for several months.

In second- and third-grade classrooms such topics as erosion, soil formation, and water conservation may be emphasized through construction of hillsides and little streams on the sand or nature table. Actually growing slips may be used, which will develop root systems, while another similar hill-

side may be covered with dead or burned-over stumps of matchstick "trees" placed in the sloping sand. With such parallel apparatus, the teacher of science education has an unexcelled opportunity for practical demonstration of the function of roots and base vegetation in holding water in soil and in preventing consequent erosion, for the water allowed to run over the burned matchsticks rapidly washes away the sand in an excellent visual demonstration.

Sometimes quite elaborate class projects may evolve through interest aroused in pursuit of nature topics by individuals and pupil groups. An unusual third-grade class project conducted by relays of student-teachers in a teacher-training institution demonstration school will illustrate this point. Following motivation and considerable groundwork discussion, the third grade undertook an imaginary cooperative expedition which was named "A Trip through Plant Land." Students were divided into four major groups for journeys into four places chosen by them as follows: (1) "The Land of Very Old Plant Forms," (2) "The Land of Conditions Affecting Growth," (3) "Partland," and (4) "The Land of Plant Kinds."

At the end of the first week of unit activity, the little tourists visiting "The Land of Very Old Plant Forms" met and read to the others the diary of their travels. They read of their trip through the woods to the country of "petrified forests." There they had seen trees which were so old they had turned to stone. The next week, the group read from their diary of their visit to "Coalville," where they had descended deep into the mines and seen the tree trunks made of solid coal. Finally, this group had visited "Fossil Rock Town," viewing many important rock formations, and several travelers placed sample bits of fossil rocks on the schoolroom nature table as proof of their visit.

Weekly reports to the groups were also given by those pupils who had departed in the direction of "The Land of Conditions Affecting Growth." Their first stop, at "Sunnyvale," brought them to a land of continuous bright sunshine,

thoroughfare busy with two-lane traffic, with many branching side roads, which seemed well traveled also. Following one of these, the travelers had reached the town of "Leafington," an extremely busy manufacturing center. While there, they learned that some of the raw materials used in "Leafington's" factories arrived from "Rootville" by way of "Stem Highway," which they had just glided over. Other materials were obtained from the surrounding countryside. Heavy-laden trucks were seen departing for "Flowerland," so the visitors followed these to a community of lovely smells and beautiful sights. Bright colors and joy were everywhere.

The last group of pupils had been to "The Land of Plant Kinds." First they had visited the low, outlying villages of "Algae," "Fungi," and "Mosses." The people seen in these places were simple, unobtrusive folk, rather small in stature for the most part, although a giant with very long legs had been seen by two girls in "Algae." He looked like a sailor, the little girls said, and he was brown from a life on the surface of the ocean. When they asked him his name, the brown sailor had said "Help!" or "Kelp!", they couldn't understand which! They didn't understand him very well, so they went on their way, joining the others in the great "Valley of Ferns," a lovely shady place where beauty of form was everywhere and the people were all green in color. One of the boys saw a salamander here, so they judged that there was considerable moisture in the air.

Pine trees were seen in the foothills, and as they motored through the higher mountains, many evergreen trees were seen growing in the snow. What beautiful country, and how healthy the growing things seemed to be! Returning via the "Mesa of Grains" across the famous "Tumbleweed Wasteland," the party stopped for refreshment at the oasis of "The Grasses," finally returning to the more familiar country of vegetables, fruits, and seeds.

Needless to say, pupils, practice teachers, supervisors, and administrators watched with extreme interest the un-

folding of this little classroom drama! All connected with the project agreed it taught many lessons in a wonderful way and that the children would remember this period of early childhood science education for many years to come.

Health Lessons

Primary children show considerable innate curiosity concerning their own bodies, and basic health lessons may begin immediately as the child enters school. Health topics must be simple, practical, and attractively presented. Care must be taken that health lessons do not develop morbid or introspective habits of thought among little children. As mentioned in connection with the primary-level studies of Insects, knowledge of harm done must take second place to beneficial forms and good health habits in keeping safe, well, and happy.

The teacher has daily opportunity to observe child reactions to health-habit training and can do as much or more than the child's own parents to further the building of strong physical bodies and good mental hygiene. Cases needing actual medical attention, such as defective hearing; adenoids, tonsils, or habitual cough, should be brought to the attention of the school district nurse or supervising physician. Traveling dental and physical examination clinics are doing great work in the field of preventive medicine and child hygiene.

Rest periods are definitely indicated in primary education; the younger the group, the longer and more frequent the rest periods recommended. Rest, with school feeding of crackers, milk, and orange juice, counteracts the nervousness prevalent in many children and puts them in physical condition to do better mental work. Attention span is rather markedly increased through rest and quiet periods.

Among the fundamental health rules taught during the early childhood years, particularly in districts where such information and training is partially lacking at home, are

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included personal cleanliness (use of soap, water, and towel), the correct manipulation of the toothbrush (teacher might check to see whether the child actually *has* a toothbrush at home!), and internal cleanliness through the encouragement of regular elimination habits. Drinking plenty of water, milk, and orange juice, deep breathing, use of clean handkerchiefs, wearing of sufficient and practical clothing, getting enough sleep and proper food are other early-childhood health topics. These may be presented by means of charts, pictures, graphs, contests, playlets, story reading, and personal demonstration by the teacher.

Nursery rhymes, devised by teacher and the group to tell of health habits to be acquired, are always effective with little children. "Little Miss Muffet," "Jack Spratt," and, "Jack Be Nimble" may be paraphrased in innumerable ways. The making of a "Health Alphabet" is an outstanding activity:

O is for Orange, juicy and sweet,
You will be healthy if one daily you eat.

Interpretation of Courses of Study

When definite courses of study are followed in primary work, their interpretation must be exceedingly elastic, permitting of wide pattern variation. Such use depends upon previous knowledge of pupils, initiative of teacher, time available, and opportunities presented for lateral excursions from time to time. Several sets of "science readers" are available for use in primary studies, and usually state-adopted series are recommended and furnished which are to be integrated with the early-childhood course of study. These have been mentioned before, and will be discussed specifically in the next chapter. In general, adoption of science readers furthers *grade sequence* in science, which is a desirable feature, and indicated correlation with the course of study is advocated. Time and extent must be highly flexible, however, for the best learning is spontaneous during this period.

Socialized Activity[1]

The trend toward science sequence organization and approximate adherence to a topic series in a mutually developed course of study must not in any way interfere with the furtherance of socialization. On the contrary, the usual effect noted may be increased intercorrelation by providing a criterion of content selection on a graduated scale, while providing preview and review on a basis of progressive development. Contrasting with a rigid, inflexible series of disconnected "science lessons" confined to definite and isolated periods, the newer thought is graded sequence organization in which not only teacher but children may obtain selection of material in a lateral sense; variation between individuals and groups being permissible. As more and more primary educators lean to this doctrine of graded selection, courses of study will keep pace, for the latter grow out of teacher opinion, in final analysis.

Selection of subject matter according to expressed need will be facilitated in the evolution of newer, broad interpretative methods, and socialization is a basic factor in such evolution of classroom techniques and teacher opinion. A premium is thus placed upon *suggestive* and *stimulative* material. The *course of study* in a socialized laboratory environment will *not* read: *Fall semester: November: Autumn and Winter Bird Migration;* for in November the socialized class may be studying a social science unit on "The Pilgrims," and may be busily engaged in unraveling from history books, encyclopedias, the famous *Book of Knowledge*, grandmother, and other available sources, all that can be gleaned concerning conditions around Plymouth Rock during the early Pilgrim occupation! Along the lines of natural science comes the probing for information concerning native plant and animal life in this region, temperature effects, hibernation of animals, harvesting and storing of food crops, what foods were

[1] Refer to discussion in Chap. 2, Trends and Methods: The Socialized Elementary Group.

eaten at the first "Thanksgivings," occurrence of wild turkeys in trees, why turkeys no longer fly, and so on from topic to topic. Building information upon previous information, socialized discussion of it, mutual appreciation of effort in securing it are all vital to the successful completion of science investigation, and the resultant tremendous interest in such research is, after all, only natural in its evolution. According to socialized activity standards, then, the grade course of study becomes an *outline* only, suggestive and indicative of general topics and approximate progress to be made in the indicated grade science sequence.

Problems in Rural Schools

A rural-system teacher may remark: "This modern primary unit idea, with its student participation in content and method may seem satisfactory in a large city school, where children from a geographically restricted locality have mutual interests, but it cannot be successfully carried through in a country school. Our first-grade children are shy, homesick, and strange. The school itself is an awe-inspiring world to a little farm child. No, our little people need restrictive guidance."

From close observation in rural districts, the author is convinced that socialized activity can and does give effective results. It is true that farm children come to the primary school from isolated lives, but to a lesser degree this is also true of the city children, who in large cities live in almost as great isolation from a sociological viewpoint. All children are facing a new world in the schoolroom, and all will respond to the same human love and kindness in development. Circumstances may render the employment of the unit program difficult or even inadvisable under either urban or rural conditions, one of which is the one-room school in isolated districts, but intelligently modified and administered to meet varying environmental factors, this method remains ideal as a socializing influence with all little children. Controlled through the careful use of graded material, education

in the field of the natural sciences becomes a gradual overlapping process, merged with progress in other lines, unaccented, enjoyable, and effectively interesting to little children.

Problems for Group Discussion and Review

1. To what extent should truth be embellished with fiction and "fairy tales" in presentation of material in the early grades?
2. When and how does the alert teacher make use of charts, pictures, and informal "snapshots"?
3. Creative expression via the "dramatic playlet" is advocated. Do you agree?
4. Make a list of primary projects which might be successfully carried out in your community.
5. In what way would seasonable variation affect project work?
6. Criticize "A Trip through Plantland" as a third-grade group project. What are its good and bad points?
7. Criticize the original games and plays presented as types.
8. Can you make up an original nature game that will teach a valued lesson?
9. Discuss the use of graded science basic and supplementary readers during the primary grades of the elementary school.
10. How may an unsatisfactory course of study be changed? State how you would proceed in undertaking a revision of the science subject curriculum in the lower elementary grades.

Chapter 7. SCIENCE IN THE UPPER ELEMENTARY GRADES

Interest in science having been fostered through emphasis upon animate nature in the primary grades, it is safe to assume that most children are eager to learn more of science as new fields of exploration are opened to them. Motivation is already present for those interested in life science, but much that has already been learned in this field has been of preliminary or preview variety, creating desire to know more, rather than bringing permanent satisfaction. Physical science has been but touched upon in connection with primary studies of weather and climate, seasons, day and night, earth, water, and sky, and similar introductory topics. The real intellectual stimulation lies ahead of the student, as he prepares for departmental science in the junior high school, or prepares within the elementary framework for advanced study.[1]

In these pages the primary purpose is to reveal possibilities of science education during the eight grades of an 8-4 or 8-1-3 plan. Other elementary administrative profiles, such as 6-3-3 or 6-4-4, may readily be fitted into the concept. In California, for example, an elementary certificate entitles the holder to teach *any* of the first eight grades. Where a 6-3-3 plan is in effect, the holder of such a certificate may instruct in Grades 7 or 8 of a junior high school, but not in Grade 9. Similar administrative regulations are found throughout the states. There is a marked trend toward *departmentalization* of the seventh and eighth grades, even

[1] Refer to the grade-sequence chart in Chap. 5, The Child-out-growth Formulation.

where junior high schools are not in existence. Consideration of *Personal and Community Health and Hygiene* and *General Physical Science* constitutes the scope and sequence of coverage indicated for these two highest elementary grades.

It is the province of a text on methods to *indicate* rather than to *dictate*, to *reveal approaches* rather than to *detail content*. Subject matter covering such a wide interest field as "science" will, of course, require the use of a great many content references on a wide variety of subjects, and each teacher will have in his personal library those which he finds most generally useful to himself in preparing presentations. The school library will be available for student use in addition to the supplementary and basic science and social science readers adopted for study in each grade.

Motivation in Grades 4 to 6

As in the primary grades, motivation is of importance in introducing the study of a science-unit phase, and if attention is paid to the same general methods of developing individual interest through group convergence, motivation should be relatively easy. Primarily, we must bear in mind that we are *teaching children* rather than administering a course of study or discussing an area of scientific material. "I do not lead my sixth-grade children, they lead me!" remarks an experienced educator. Parenthetically he adds: ". . . and they make good leaders, too!"

While a general theme may be carried out in pursuing science studies as well as in history, geography, or the humanities, individual interests concerning a particular phase of investigation often differ widely Let us then allow each student in the upper elementary grades as free a rein as possible in choice of science problems and in the working out of their solutions. Children in the fourth and fifth grades are far from artificial; they do not simulate interest in school or in schoolwork. To hold strictly to a given topic at a given time is to stifle in some degree the individual initiative, the subconscious longing to explore, which is latent in every

growing child. To this end, motivation and methods of approach will be flexible in the extreme.

The study of *one* topic, particularly if that topic has been touched upon in previous primary work, will often develop laterally into a series of investigations into several related fields *Social consciousness* is one peculiarly far-reaching angle prolific in possibilities of interest development. Geography, resources, commerce, climate, native plants and animals, foods and customs of the people are pertinent examples. All these offer opportunity for interweaving and correlation of science with social consciousness as it matures in the growing elementary classroom.

Tact must be used in bringing about seminar-type discussions of the general course-of-study subject indicated for investigation in the sequence. Of course, no teacher in his right mind would bluntly announce: "Tomorrow the class will study *reptiles*, because the course of study in use in our glorious school system calls for a study of *reptiles* at about this time during the fall semester!" However, not a few teachers observed personally by the author have made "motivation" presentations quite similar in effect. Comment on the natural results of such procedure is superfluous.

Rather, let us allow (or *seem* to allow) suggestions to come from the children, awakening desired interests through reading assignments, pictures, personal preliminary child talks, and similar devices. Let us illustrate. Suppose that the general topic in the superunit grade-sequence outgrowth for a given period in the division of social studies is "AFRICA." The skilled teacher artfully fences for an opening through such current events as a motion picture shown locally with an African background, or a child-read "comic book" (which is usually anything but comic) featuring such a locale. An article concerning African exploration may appear in *The National Geographic* or other magazine. These things should be utilized.[1]

[1] See the suggested list in Part II, Resource Aids: Magazines Useful in Elementary Science Education.

Spontaneity is the keynote. One of the girls may appear wearing a cheap diamond ring of a type commonly prized by youngsters. A discussion of real diamonds, how they are formed in nature, how they are obtained from the earth, why they are valued so highly, where the largest and best ones are found in South Africa, who the people are that work in the diamond mines, and similar topics, easily ensues, and a preliminary interest-motivating presentation is indicated.

A boy returns to his classroom from a brief midwinter vacation on the southwestern desert, with face browned from the sun and outdoor living. The children gather around to listen to his adventures and soon are speaking of arid, dry regions they themselves have visited or have seen in the "movies." A resulting seminar discussion leads to the Sahara, why it is so dry, and what animals, including people, live in or near it. Perhaps a circus arrives at the county seat! Such a fortunate occurrence will furnish material and incentive sufficient for an entire semester of projects and investigations. Camels, elephants, tigers, monkeys, snakes, and even a side-show "wild man" from the Congo stimulate young minds to wonder and to want to know.

How? Why?

Once the stimulus contact has been made and the student is on his way, the experienced teacher stands aside. Bear in mind that he does not step *out* of the picture. He stands ready to guide and assist in the working out of problems and is kept busy doing just that without resorting to command dictation at any stage This is basic psychology; the initial enthusiasm must be allowed full developmental sway if it is to be effective. Think of your own reaction to a new enthusiasm or eager plan. You do not relish disturbance in the initial stages of your own enthusiasm; neither will your pupils. This is important and should be emphasized.

As the initial fervor wanes, as it naturally will, begin to ask your young people "How?" and "Why?" In the re-

sultant exploration, "What?" "Where?" and "When?" will tend to solve themselves. In your first-semester, sixth-grade study of Africa, do not, for instance, bluntly demand information from your social studies research groups concerning Carthage, its former trade, population, and geographical location on the southern shores of the Mediterranean A better way is to wonder with the students as to *how* and *why* Carthage came to be located where it was and why it remained an embattled metropolitan center through the centuries. Why has this place been, for hundreds of years, one of the great strategic locations of the Mediterranean area? The *American Expeditionary Forces* "took off" from a protruding point in northern Africa for their invasion of Sicily and Italy during the Second World War. Why did they embark from this place? These questions stimulate research, and research turns up supplementary facts. Who finally destroyed this great city? Why was it destroyed? What did the conquerors do in order to make certain that there would not arise on the same spot a new Carthage? Why was the measure so effective? In science, supplementary research explains both why and how, in many instances.

Natural environmental factors are an important phase of science studies in the upper elementary grades and should form the basis of most of the teacher-training preparation in physical and life science in our teacher-training institutions, together with a thorough mastery of basic principles such as osmosis and photosynthesis. Temperature as a limiting factor, altitude as an intangible plant barrier, seasonal changes, wind movements, land forms, clouds, rain, and powerful erosion forces such as sandstorms—all are important in enabling the teacher to phrase his questions and answers in a scientifically stimulative manner, thus encouraging genuine research habits at the elementary grade level. Myriad problems develop in consequence of such an enlightened background: the effect of excess alkalinity on plant growth, the anatomically interesting adaptations of

camels for desert travel, xerophytic plant types, and native food crops (to conclude the African correlation) all arise from stimulative questions as to the how and why of facts and circumstances.

Investigations into reasons behind environmental phenomena often lead students or groups of students far afield. Each junior investigator is encouraged to weigh carefully the environmental factors which may determine the success or failure of his problem; studying causes, observing effects, and drawing conclusions upon the basis of his observations. Thus the physical and mental development of the child is mingled with elementary reasoning as the craving for self-expression is allowed to take its course. By this method children show excellent tendencies toward concentration as individuals or groups on problem solving on a *how-why* basis. There is very little "slacking" or cheating, since each person is made to feel that this is his own problem, to be worked out in his own way, for the furtherance of his own objectives, including the social progress of his classmates.

Activities under Difficulties

There is little doubt among elementary specialists today that the activity program offers ideal training in life leadership. Scientific research ability, commensurate with chronological and psychological age, is certainly furthered by the activity method, since *interest* in solution of problems on a basis of *how why* reasoning is the essence of the program. Mastery of skills and facts is another facet, something which must be watched over, supervised, and regulated like a manually controlled heating and ventilation thermostat in a room. Emphasis upon mastery in unit progress has been discussed in a previous chapter.[1]

However, it should be noted that conditions and personnel, including supervisory opinion and training, are not always inclined toward progressive methods. Sometimes educators

[1] Chap. 2, Trends and Methods.

subscribe in theory to most concepts of the plan, but practical obstacles which hopelessly block its competent achievement. are recognized which prohibit its immediate adoption. Sometimes under conditions which are less than adequate, a trial of such procedures produces little mastery and less genuine social consciousness, and a pendulum backswing is indicated. Our history of education is replete with similar instances with relation to all innovations, and time plus intelligent effort in our teacher-training institutions graduating continual generations of new blood into the profession will moderate such conditions considerably.

In many classrooms of many school systems, supervisors and teachers adhere closely to definite time plans and achievment goals in terms of pupil progress on a closely supervised basis. Science, as such, is limited to a definite period of the week, or certain times of the day, some days. The actual number of *minutes per week* (!) is actually specified, from an average of 125 in Grade 4 to 250 in Grade 6. The number of pupils per room and per teacher, in other words, the "teaching load," is a further determining factor.

As a matter of practical pedagogy and administration, space and equipment for handling large numbers of young people is often limited in a crowded school system, and most urban systems are presently crowded beyond reason, because of an increasing school population as a result of the postwar birth rate. Every available square yard is utilized by alert administrators under pressure from above for production along factory models. Activity programs *can be*, and *are*, carried on under such pressure, but time and space factors make it difficult, requiring not only training but initiative. Under such conditions most teachers find that a "unit period" each day, given over to consideration of group problems along socializing lines, is most productive of results. Ideally, all periods overlap, contributing to the success of each part of the whole; but where ideal conditions do not exist, partial effort is preferable to no effort at all.

What is accomplished with comparative ease in the hallowed cloistered laboratories of the "demonstration school" during the period of undergraduate or graduate teacher training, is quite another problem in "Public School 117," in the heart of the manufacturing district in one of our large metropolitan centers! Under such circumstances the more formal method of approach and follow-through has the distinct advantage of controlling the learning process in science, as elsewhere in the curriculum.

It is well for a young teacher to know these things, and sometimes he does *not* know them, which results in early frustration and loss of perspective. The teacher should be cognizant of *each* method of approach, arranging his work along the more liberal socialized activity plan where he has administrative approval, time, space, facilities, and sympathetic supervision, or organizing definite lessons in orderly systematic fashion where indicated. The local course of study, plus conversations with other teachers and with the supervisor and principal, will indicate the philosophy followed. As will be emphasized carefully in the ensuing chapter on Unit Development, teachers who are competent will secure good results in terms of child progress in skills and content knowledge through the intelligent application of *either* method.

Let each young teacher weigh current local public opinion, supervisory and administrative philosophy, and physical-plant adequacy as he becomes familiar with the situation before he may feel justified in making radical changes in classroom procedure and technique. It may be found that prejudice is based on ignorance and hearsay, that older teachers may genuinely *desire the help* of the young graduate imbued with the very latest science educational techniques and philosophy. If such is the case, the young beginner will find himself a *leader* already, on the basis of his modern viewpoint and training. Friendly inquiry and professional humility in the presence of specific training or experience

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science subject content to personality and philosophy are definitely indicated if each elementary teacher is to do his best work in a happy classroom environment. The construction and maintenance of an adequate course of study is in truth a gradual process, extending through the years and never fully accomplished. The concept of mass blanket prescription fades as educators turn to the consideration of elementary classrooms as individual teaching situations, none like its neighbor, yet all of the same general grade level.

State-wide courses of study indicative of general grade progession are being experimentally tried out in several states, with promise of excellent results in terms of inter-system integration. Stress on one phase of science education may be indicated in one situation while unnecessary in another, hence arrangement and rearrangement possibilities are extremely fluid. Within a given system, also, the far-reaching conditioning effects of general major social science units exert influence upon minor science subjects, as will be brought out in the following chapter, Unit Development.

As stressed during the previous chapter, Nature Study in Early Childhood, children exposed to *planned sequence* achieve best results in terms of progessive education, chronologically speaking. Pupils change from teacher to teacher within any given school; they change from school to school; they often change from city to city as their parents move from place to place. In the first two instances, courses of study in science education may exert control; in the last situation only intercity cooperation and state-supervised sequence programs can bring about unity in progression. The National Society for the Study of Education recommended a continuous flow of science educational sequence as long ago as 1932.[1]

A particularly satisfying development of the attention to science sequence on a national scale has been the publication

[1] Refer to discussion in Chap. 3, Philosophy and Administrative Pattern.

will be found to be reciprocal among intelligent classroom teachers.

Use of the Course of Study

A well-organized teacher-produced course of study is not intended to be rigidly followed in any event. The greater principles of science as a factor in the whole educative process should be indicated, together with suggestive sample activities, lists of desirable skills, and sources of material and teaching aids. In a sense, this entire book meets such a definition, for at best an outline is only as good as the teacher who interprets it. Philosophy and point of view are paramount, assuming that undergraduate science training has been adequate. If it has not been, the teacher must return to classes and laboratories during summer schools to refresh science content.

A course of study should *suggest* material and procedure to intelligent instructors, not cram them down their collective throats. In setting up a plan of action, therefore, we must recognize the fallacy of any outline fitting all localities in science content, especially the all-important concept of *environment*. A capable, well-trained teacher, confronted with a mediocre or out-of-date outline, immediately makes mental notes in line with experience shown in the elementary grades concerned. Certain topics may be over- or under-valued, in his opinion, the sequence may be poorly thought out, or topics irrelevant. The result is a revised personal plan of action which may bear little other than superficial resemblance (for "lip-service" purposes) to the original and official intellectual menu set before him.

On the other hand, the most complete, voluminous course program, interwoven through literally *volumes* (several times plural in some instances) devised laboriously and specifically with local conditions in mind by experienced, up-to-date teachers, will often produce inferior results when poorly interpreted and incompetently developed. Adjustment of

groundwork in atmospheric pressure at various altitudes, wind currents, temperature changes, erosion factors, air transport,[1] and the elements of applied chemistry and physics. It is, of course, far too early for anything resembling serious study of formulae, organic chemical concepts, or even basic physical laws; these will actually begin to make themselves known during the junior high school work in general science, as discussed in a later chapter. Building of a *scientific attitude of mind* and toward an *appreciation of the worth-while nature of scientific research* in the physical science fields is, however, a very real objective for the upper grade teacher.

Heat, sound, electricity, light, gravity, energy transformation, and the chemical factors of environment become increasingly evident to the maturing student as they affect the interrelations and interdependence of living things. The youthful investigator, meeting these controlling influences in the course of his embryonic research, naturally wants to learn more about them as his scientific curiosity is whetted. The "nature study" of past primary-elementary grades is then metamorphosed into a seeming preview of what has been accepted to be "General Science," as topics arise for investigation in the upper grades. We live in a rapidly moving mechanical and physical period of the world's history, which fact is mirrored in the popular terms: the "air age,"[1] and the "atomic age." Even at the university-research level, we find that investigations in the life sciences themselves have become largely dependent upon physical science backgrounds. The physical sciences may no longer be put off; work in the junior high school will proceed the more rapidly if foundations are laid here.

A gradual inclusion of physical science topics within the

[1] The elementary school teacher of the upper grades should send for supplementary and illustrative materials from the air lines, such as United Air Lines. See listings in Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters.

of several sets of graded "science readers" by reputable companies. A general criticism of content, voiced earlier in the text[1] regarding the preponderance of Eastern life forms used as illustrations and in context is still a valid (if regional) criticism of nationally distributed materials for children. Overbalancing this, however, is the marked impetus given to graded sequence through adoption of sets of these child guides in science. Vocabularies have been checked to ensure the use of words within the understanding and grade list of pupils; they are prepared by leaders in thinking in this relatively new field, and by virtue of their recent publication the readers contain relatively modern science facts and achievements.

Every virtue of the yearly texts on specialized topics is incorporated, plus unification of science subjects in series, building toward environmental appreciation which increases as the series is studied progressively. Teachers' manuals are usually available for each grade, which help materially those instructors whose technical preparation has become out of date. This is the modern trend in elementary science education: *the emphasis upon graded sequence in a progressive study of environment as it affects life in a democracy.* Education in the upper elementary grades is particularly pointed toward orientation of the child in a changing world into which he will soon be graduated. Science education is an important and continuous factor in present-day life orientation.

Content for the Upper Grades

If education along scientific lines is designed to aid each child in orienting himself in terms of a world environment overshadowed by atomic and hydrogen bombs, supersonic speeds, and kindred mechanical and physical phenomena, the study of upper elementary grade science will include

[1] Review the discussion of type forms and lack of socializing integration in Chap. 5, The Child-outgrowth Formulation.

PROJECTS

Occasionally the upper grade teacher will find that his class will discuss projects in science almost exclusively for a time, freely developing ideas in this field and showing a relatively intense interest in use of the nature table, demonstration area, and available references.[1] Children take keen interest in setting up an aquarium of their own. They enjoy collecting and making mounts of insects and they like to personally experiment with plants.[2] Inquiry upon the part of the teacher often reveals a surprising number of semi-scientific interests at home, which young people are eager to show others in the class. This attitude, demonstrated in elementary school "Hobby Shows," mirrors the pride of adults in their own special interests. We have learned in a previous chapter[3] of the concentric orbit which characterizes child projection techniques. The project method elaborates upon previously acquired skills and knowledge, building progressively in ever-widening experience areas in a *learn-by-doing* atmosphere.

The teacher will do well to remember that the things about a project which interest a child and sustain his efforts in carrying it forward differ both in quality and in quantity from adult concepts. Quality difference is shown in the strong feeling upon the part of the child that he must do the thing *himself* and that he wishes the act or event to be *immediately* satisfying Quantity variation is shown in the length of *time* voluntarily devoted to any project before attention wavers to new horizons. Adults lean to such avocations as the design of fishing lures in *anticipation* of future fishing trips, as well as to home motion pictures, color pho-

[1] Upper grade teachers should send for the "Turtox Service Leaflets," a helpfully suggestive series of "how to do it" pamphlets published and sent free of charge by the General Biological Supply House. Address will be found in Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters

[2] Refer to Chap 11, Laboratory Experiments with Plants.

[3] Chap. 5, The Child-outgrowth Formulation.

elementary curriculum has a further advantage in that it tends to smooth a path once very rough: physical science in the eighth grade being formerly a difficult and too rapid transition from elementary school topics and more general terminology. We cannot safely put off the study of physical factors in the elementary grades. Indeed, we do not wish to do so, and the results observed in lessened shock, increased interest, and broadened knowledge in advanced sixth-grade students confirms the wisdom of this procedure. This broadened concept culminates, according to the Child-outgrowth Formulation, in the second-semester sixth-grade study of "The Universe" as an entity beyond the earth, which lays a solid foundation for adolescent thinking in terms of planetary astronomy, geology, paleontology, and sources of energy upon the earth; all topics which build upon previously acquired knowledge and point the way for further investigation.

Intercorrelation

Subjects will be intercorrelated in the upper elementary program, and science education subscribes most wholeheartedly to this philosophy. The class in art will make pictures showing plant flowers or insect butterflies as the opportunity presents itself. Much of adult art-school postgraduate technique is concerned with nature in art and art in nature, including the human body itself. In elementary reading, stories of plant and animal life, scientific discoveries, and past achievements in science may be selected as seems appropriate. "Hikes" during outdoor physical play periods or afterschool "nature club" activities may be correlated with science observations. Oral and written English will be interwoven with paragraphs about birds, experiments, new discoveries, and other topics. Arithmetic may readily be incorporated in the interweaving process, if the teacher will take the time and trouble to work out related problems, with a marked improvement in interest span. So it is in all fields and skills, as will be shown specifically in the following chapter.

The story of pineapples
The story of coconuts
The story of camphor
The story of cinnamon
The story of raffia
The story of burlap (jute)
The story of rope (hemp)
The story of chicle (chewing gum)
The story of nitrate
The story of quinine (cinchona)
The story of wheat
The story of corn
The story of oats
The story of citrus fruits
The story of potatoes

Room Exhibits Demonstrative of Unit Investigation

The natural life of Alaska
The natural life of Canada
The natural life of Newfoundland
The natural life of Mexico
The natural life of Central America
The natural life of Brazil
The natural life of Argentina
The natural life of northern Europe
The natural life of Mediterranean Countries
The natural life of northern Africa
The natural life of central Africa
The natural life of India
The natural life of Australia
The natural life of the Orient
The natural life of the Pacific islands
Electricity (sources, transmission, domestic uses)
Plastics (origin, product types)
Transportation by water
Transportation by highway
Transportation by railway
Transportation by air
How we know about weather (Weather Bureau charts, etc.)
How we know about the stars (astronomical observatory)

tography, amateur radio, and garage-bench carpentry as expressions of past pleasures and along lines of continuous *planning*. Child psychology in the elementary grades emphasizes current, immediate satisfaction and contagious enthusiasm. The teacher has but to provide space and encouragement through time allotment to watch his charges learn through contemporary social interchange. In addition to the "Pet Show," "Hobby Show," "Gardening," "Insect Collecting," and others mentioned in previous chapters, a more inclusive project list follows for the upper grades:

Diorama-type Group Projects

A class museum
A class circus in miniature
Raising silkmoth larvae
A conservation exhibit
Arctic life demonstration
Antarctic life demonstration
Jungle life demonstration
Forest life demonstration
Mountain life demonstration
The sea beach at low tide

Demonstration Table Exhibits

Fabrics (silk, cotton, wool, or linen) preparation
Rubber preparation, including sources
Leather preparation, including sources
Wood preparation, including sources
Paper preparation, including sources
Articles (such as buttons) made from shells
The story of cork
The story of turpentine
The story of coffee
The story of tea
The story of cocoa
The story of cane sugar
The story of maple sugar
The story of beet sugar
The story of lettuce

may not be so advanced in their science preparation, being of lesser I.Q. rating, or perhaps of fourth-grade status in a mixed group. For these, the science games and science playlets are still useful, and presentations of a little more advanced nature may successfully be used. Examples of science games and playlets are given here for type patterns.

Games

"Animal Naming"

A fourth-grade child, standing before the group, imitates through pantomime the actions and peculiarities of some bird or insect which has been observed in field or forest. Invertebrate or vertebrate types may be used as the child wishes. The pupil raising his hand and first correctly guessing the answer may be given a token, such as a bit of cardboard brightly colored. When the games period is over, the pupil possessing the most colored cards is declared the winner.

"Flower Naming"

Similarly, flowers may be learned and reviewed in this manner. A dozen varieties of flowers may be collected and exhibited on the science table. A graph should be drawn on the board, twenty squares wide and twelve high. Each pupil may then be given a slip of paper and instructed to write down as many of the flowers as he or she can remember. After all have finished, teacher will ask who has the least number. If a pupil has only four, and these are checked as correct by the teacher, the pupil will then go to the board and fill in four squares of the graph with colored chalk. One pupil with seven answered correctly will fill in with seven squares in color, and so on. The children may write their names opposite their graph squares in color, if the teacher wishes to indicate pupil standing in the contest in a semipermanent manner. Those pupils knowing all twelve names would color all twelve squares in the graph, and stand as perfect.

How we know about the history of our earth (geology)
How we know about prehistoric plants and animals (paleontology)
The marvels of chemistry today
What physics does for mankind today
The oxygen cycle in nature
The carbon cycle in nature
The nitrogen cycle in nature

Such topics as the chemical element cycles may seem, at first glance, to be too comprehensive and too difficult for elementary students. It is true, however, as any sixth-grade teacher of competence will verify, that intelligent sixth-grade students can handle almost any science presentation in which they are interested. They can understand and can work out projects equal in difficulty to those of the junior high school, if they choose to do so. The determining factor is *interest;* and if the mature elementary student is fascinated by a science problem, he can go far indeed. If the socially significant angles of the subject are stressed and the chemical formulae omitted, science students will be quite capable of handling physical and life science topics of this nature. An important concept of environment in the scientific sense will be established, which will materially aid the student in adjusting himself to the approach of departmentalized seventh- and eighth-grade instruction.

Games and Dramatic Playlets

As has been indicated in discussing the primary grade level in the previous chapter, games and dramatic playlets have an important place in science principle presentations to children. The use made of these media is, of course, optional with the teacher of upper grade science, and he may find that his class is more interested in practical research than it is in playing games. Many fifth- and sixth-grade classes are, especially if sectioned for intelligence quotient as is currently done in many metropolitan centers. Other classes, however,

for his laboratory. Explanation of the idea to a competent electrician, however, will bring establishment of a permanent laboratory instrument which is of great interest to young people and to supervising administrators, being of scientific value in education as well as genuine source of real classroom fun.

Playlets

"The Little Green Worm"

Number of pupils: Twenty.
Presentation time: Twenty minutes.

Act 1

The rising curtain discloses a forest glade (pupil trees and flowers). A little boy dressed as a caterpillar crawls downstage, nibbling at leaves (flowing green sleeves of pupil costumes) as he crawls along. He seems to have a very hearty appetite, as leaf-pupil sleeves are folded up to the armpit at an astonishing rate as he passes by!

A boy and a girl come skipping through the woods, hand-in-hand. When they see the little green "worm" crawling among the leaves, the little girl screams and backs away, crying that she does not like creepy crawling things. The little boy picks up a big stick and is about to crush the worm, when a beautiful lady (teacher!) appears and inquires as to the danger. When her attention is called to the crawling "worm," the beautiful lady explains that it is quite harmless to people and will soon stop eating leaves. If they will watch closely and not kill the "worm," she, as Mother Nature, will cause a marvelous transformation to take place, replacing the worm with a creature of fairylike beauty. (First-act curtain falls, as the children sit down on a log to await the promised magical event.)

Act 2

This act is an interlude and reveals the sleeping worm as it lies in its transparent cocoon of cheesecloth and old sheets.

"Jigsaw Puzzle Game"

These may be purchased for use with fourth-grade children in the open market, or they may be made to illustrate unit topics in the class during arts and crafts period. In either case the parts should be brightly colored, and not too many parts in each set, for time is a factor during school hours as well as fourth-grade attention span. Fish, birds, airplanes, or anything connected with the science major or minor unit may be used. Numbering the parts of each set will aid in preventing loss, which will not be excessive if the sets are not too complicated. The fastest completed puzzle wins, of course.

"Visual Matching Identification"

This equipment may be used with children in the fifth and sixth grades to very good advantage indeed. It consists of a series of box openings, wired at the rear in such a manner that contacts with each box opening or shelf portion may be made with electric lights in each box. Wires run from each box to a set of plug-socket openings which may achieve contact in the same manner as a switchboard operator "plugs in" telephone calls. Along one side of this permanent laboratory setup are a series of plug openings into which card names fit. Placing one plug in a name socket and the other in a socket corresponding to the name, a light lights in the square box container which houses a specimen of the same name as is marked on the card. If the word "crow" is marked on a card and inserted in label socket no. 5, for example, and the child puts the selector plug in the socket next to the box containing a mounted crow, the light in the box will flash on, contact being made. If the child connects the word "crow" with a box containing a mounted sparrow, contact will not be made and the light will not flash on.

Children, and adults too, love to play this visual identification game, which can be used with any variety of science topics; names and mounts being interchangeable. The teacher, unless extraordinarily skilled in electrical mechanics, however, may not be able to construct such a display case

eaten. Mr. Swallow calls out: "Is everyone ready?" Chorus: "Flap, flap! Here we go!"

(*Curtain*)

Objective: This little playlet may be used to enlighten a dull afternoon, emphasizing at the same time hemispheric climatic factors influencing bird migration.

Problems for Group Discussion and Review

1. Discuss pupil freedom as a factor in unit motivation in the elementary school.
2. How would you bring about pupil interest in the study of Africa, for example?
3. Which of the following seem most important in science: "What?" "Where?" "How?" "When?" "Why?" Give reasons for your answers.
4. What psychological advantages are enjoyed by the teacher who can say: "I do not lead my children; they lead me?" What are the inherent dangers of such a schoolroom situation?
5. Discuss the difficulties of unit-activity teaching under adverse environmental conditions.
6. In what ways may a progressive program of teacher training prove misleading to a young teacher in preparation for actual duty?
7. Explain what is meant by an "elastic" course of study.
8. What is the great advantage of graded sequence in the child-outgrowth formulation as recommended in this and previous chapters?
9. To what extent does elementary nature study today assume the physical science characteristics of junior high school "general science?"
10. Discuss intercorrelation of curricular and extracurricular activities in the elementary science program.
11. List suggestive group and individual projects suitable for American elementary schools.

While it sleeps, the flowers dance and sing downstage center. As the dances, signifying the lapse of time, come to a close, the dancing flowers separate, leaving an avenue upstage. The cheesecloth cocoon opens slowly (having been hidden during the dance by trees and foliage), and a beautiful little girl emerges in costume, dancing downstage in rhythms symbolical of the metamorphosis of the butterfly! The boy and girl, of course, have changed places in the "cocoon" while hidden from the child audience. The beautiful lady representing Mother Nature and the two watching children joyfully clap their hands as the curtain falls.

Objective: Teaches insect beauty in nature and illustrates a life history transformation.

"Traveling"

Number of pupils: Twenty.
Presentation time: Ten minutes.

The scene is laid in the frozen north. Mr. Cold Wind rushes in from the wings, shaking the "tree" where Mr. and Mrs. Robin live and blowing his cold breath in all directions. After Mr. Cold Wind finally leaves in a great disturbing blast (have you a special boy pupil in mind who could play this part to perfection?) Mr. and Mrs. Robin come out to find something to eat for lunch. They look under the "trees" (pupils) scratching here and there, but no "insects" are to be seen, Mr. Cold Wind having disturbed those which were lying about on the stage and which have already crawled away quickly. While they are looking in vain for insect food, Mr. Rain rushes in and sprinkles them with splashes of water. Now comes Miss Snow, covering the ground and Mr. and Mrs. Robin with bits of cotton and tinsel! The Robins shiver dismally.

After Miss Snow and Mr. Rain finally leave, Mr. Robin spies the Swallow family in the snow, also looking for food. He calls to them, and a downstage neighborly council results in mutual decision to leave at once for their annual vacation in the sunny southland, where leaves are green, the sun is warm, and there are lots of flies and mosquitoes to be

Chapter 8. UNIT DEVELOPMENT

The importance of *careful planning* in undertaking the development of a teaching unit is apparent to all educators. Analysis of materials available, child development, scope and sequence, and kindred problems of correlation is particularly prerequisite to the carrying out of a successful activity program in science. The relation of each factor to others in the curricular program must be clearly determined and its probable contributions weighed and evaluated. Methods of approach must be considered, and virtually the entire procedure at least tentatively decided upon before the new project is brought to the attention of the class. Factors to be taken into account and the sequence of eleven steps to be carried out in organizing a science unit will be detailed here.

Analysis of the Problem

A clear analysis of the problem must be made at the outset. This will include orientation of the topic into *major* and *minor* divisions. If the new unit is to be an extensive, all-inclusive one, such as "A Survey of the World and Its Products,"[1] it will be classed as a major activity. Time allotment for an entire semester, or an entire year, will be necessary. Relation of the work of the semester or school year involved to the work of other semesters and other school years must be clearly indicated. A minor unit, on the other hand, involves relationship of the part to the whole, and approximate time allotment as a part of a semester's study will be made on the basis of days and weeks, rather than of months.

Organization of the unit, whether major or minor, further

[1] Refer to Chap. 5, The Child-outgrowth Formulation.

12. Do you consider the *oxygen*, *carbon*, and *nitrogen cycles* too advanced for the sixth grade? How about *plastics?*
13. How may games be advantageously utilized in progressive elementary science education?
14. See if you can improvise a worth-while, original natural science game.
15. How may the group dramatic presentation be utilized in elementary natural science education? Give examples.

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[1] Refer to Chap. 5, The Child-outgrowth Formulation.

involves a supplementary presentation of the problem in terms of "how" and "why." In what ways will the study of this unit constructively contribute to each individual child, as well as to the class as a whole? This question must be clearly answered; first, in the mind of the teacher, and, second, in the minds of every pupil who is to study the unit.

Location of the Classroom

In science, as in social science, the particular environment of the classroom and the school itself is of primary significance. Plants growing in the schoolyard or in homes or parks nearby, together with animal pets, residents of the local zoo, or specimens to be seen in a nearby museum must be taken into account. All neighborhood and community facilities, including parental attitudes, must be considered as contributory environmental factors.

Grade Level of the Children

The social, psychological, and mental age of every child in the room must be considered. This will include not only a routine examination of pupil records, which step is assumed in every modern classroom as a matter of administration, but also an evaluation of habits and behavior patterns. Is the child ready for such study at this particular time? Is the class as a group prepared for the unit?

Previous studies of scientific subjects in lower grades may be checked through pretesting the children of the grade level, measuring carry-over to the present class. Studies which are to follow a given grade level in the general elementary science sequence should also be given consideration at this time.

Availability of Contributory Materials and Information

In addition to the checking of gross materials in the community, as enumerated above, a survey of books, pamphlets, mounted and unmounted pictures, and similar workshop tools must be completed. School as well as city and/or

county libraries should be canvassed, and bibliographical aids noted for later recommendation by research committees. In this connection, the fact must be borne in mind that these are child references, not adult, and suitable materials in addition to the grade readers must be provided for each specific unit. In most states a system of supplementary readers is available for calls by teachers and the readers are obtainable for temporary use for special studies and held in the system or elementary school library for such issuance.

Many cities and counties feature *audio-visual education* departments which have as their principal function the preparation and distribution of helpful research materials and information for grade school and secondary school use. The bulk of such utilization is, of course, in the grades below the high school Not only lantern slides and motion pictures are available, but also small models, graphs, charts, still photographs, and phonograph recordings as examples of aids on call by the teacher for stimulation of research groups.

Time Allotment

Approximate time allotments should be made well in advance, in order that sufficient time for proper elaboration of topics may be available. Such apportionment must of necessity be extremely flexible, but it is important that the teacher have in mind, well in advance of need, the number of periods, school days, and weeks which may be used in the study development. Holidays must be taken into account, and if field trips are contemplated, their times must be checked with administrative and supervisory staff members far in advance, in order that approval and transportation reservations may be obtained. When parental permission for such field trips is to be obtained in writing, time must be allowed for this step An even flow of progressive developmental sequence within the classroom can only result from a careful analysis in advance of approximate time allotment for various phases of the unit development.

Establishment of Basic Objectives

What underlying factors have influenced the choice of the major or minor unit topic? What fundamental comprehensions, ideas, and growth opportunities are to be established through its study? What attitudes of mind and technical or manual skills are to be acquired? What attainments in viewpoint and habits of thought are to be established? In what specific ways shall the unit be made to contribute toward the educational growth of individuals as well as of social groups?

Motivation Procedure

This phase of unit development is important and far-reaching in its significance, since interest in the topic and a driving desire to learn more about it will determine to a large degree what pupils will derive from the study. The introduction may be gradual, perhaps taking the form of an inspiring oral presentation by the teacher, or possibly through the reading by one of the pupils of a written introduction prepared by the teacher in advance. The former is preferable, being the more informal. A lively discussion of the introduction should follow its presentation. Stimulate the children until they just *have* to ask questions! Then allow those having any previous information relative to the topic to lead interest-promoting discussions. Undertake the preliminary evaluation of contributory sources with the class, reading aloud brief selections from some books on the tentative list.

"Think out loud" during this portion of the motivation. Encourage talk, thought, and questioning. Student committees may be nominated to look for further materials and book references on the subject. Modification of the original plan and time allotment in the teacher's outline may need to be made in order to conform to the pupils' suggestions. Care must be exercised during this period that slower students be allowed to participate in the discussion, and that the brighter, more alert students do not contribute all

the material and suggestions. It is the less alert group who always needs the stimulation. The teacher should not talk too much after his original suggestive presentation. His attitude should be one of alert guidance during the motivating time, directing trends of thought and indicating his ideas through suggestion rather than through forcefulness.

Developmental Activities

Projects by individuals, committees, and by the class as a group in service together for the common good are now begun. Reference reports, field observations, and council or "round-table" discussions take form as the children plunge into problem solving through activities. Youthful zest and enthusiasm must be tempered at first with zeal in obtaining a degree of accuracy and respect for truth. If previous teachers have done their work well, there will be a decided carry-over in pupil method and diligence in research.

Social science plays a large part in the orientation of every science unit and vice versa, a general historical and sociological background making an excellent foundation for the development of any unit. Knowledge of what has gone before, leading to a discussion of present-day problems and policies, economic values and civic trends, will furnish teacher and pupils with a varied array of problems and projects. Individual and group investigations arising from a historical résumé develop from small beginnings into basic comprehensions bearing upon the problems to be solved. Observational visits and field trips should be encouraged for individuals, committees, and the class as a unit, in order that all may see and learn firsthand of the social factors involved. Collection of materials is always good; articles and specimens being assembled for use on nature tables, in class museums, and in dioramas in the school corridors. Experimental results must be related to or observed by all students, results being noted and recorded; the form and extent of experimental observation and conclusion varying with the

grade level. Free reading of poems, stories, magazines, articles, and book references will continually provide new material.

Oral discussions along socialized lines may well be introduced at this stage, individuals having progressed sufficiently in their reading and experimental handwork to contribute definitely to the assimilative processes of the class. Socialized discussions[1] should result, each pupil presenting his or her ideas for the common good.

Integration of Allied Knowledge and Skills

This phase is the crux of the progressive educational program. If the activity plan is to justify its wide current adoption throughout the nation, meticulous attention must be given to the three basic R's: reading, 'riting, and 'rithmetic. These classical three fundamentals are still at the foundation of American life and success, and any system of education which tends to gloss over or in any way neglect basic drill in these essentials is doomed. Games, projects, socialized discussion groups, sectioning according to ability, sex, or intelligence quotient, dramatics, and out-of-door creative workshops have their place in sustaining interest and rounded leadership. We must, however, take continual care that we turn out elementary graduates who can read, write, spell, and do simple arithmetical problems well enough to balance a checkbook. After these foundational needs have received attention, we may proceed to other factors in the well-rounded curriculum.

Oral English, art, music, rhythms, health projects, and dramatics may be brought into the picture after provision has been made for arithmetic and the language arts. Work on original poems, stories, articles for the school or city paper, and simple notebook preparation will contribute to individual expression. Visual education materials will be integrated at this stage, including still pictures, charts, lantern slides, filmstrips, kodachrome slides, and motion pictures

[1] Refer to the discussion in Chap. 2, Trends and Methods.

as well as models. During the social science introduction a survey of geographical distribution of raw materials, manufacturing processes, production, distribution, and marketing factors may be considered, which will in turn facilitate the introduction of arithmetical calculations, spelling, oral and written English, and kindred subjects. Creative activities arising from such correlations will incorporate original games, riddles, art, dances, and dramatic playlets, together with scrapbook and poster making, drawing, weaving, painting (including finger painting in the lower grades), stenciling, and clay modeling. Interpretive dancing to the music of phonograph recordings as well as singing of nature songs from records and songbooks interweave rhythmic music with the unit.[1]

The Culmination

At the conclusion of the unit a summing-up period will be found useful as a review, in advance of formal and informal examinations, and as an outlet goal for pupil ambition and purposeful effort direction. This "culmination" may take the form of an oral round-table discussion by the teacher, student leaders, and class participation. Sometimes panel discussions are held, similar to those conducted at teachers' institutes. In many classrooms a dramatic presentation is evolved through the preparation of integrative reports and pupil presentations. This may be given as a class play, or before several classes, or even before the entire school. Many teachers of considerable experience feel that a semidramatic playlet culminating the work of the group may best be given before the parents of class members, who have been invited to attend by specially written invitations prepared by pupils Fathers as well as mothers usually appreciate such handwritten invitations and try to come to watch their children, thus showing interest and a cooperative attitude. Conversely, children react well to such a considerate

[1] See Part II, Resource Aids. Instrumental and Vocal Phonograph Recordings.

attitude upon the part of their parents, to their mutual good will and benefit. The school and the home are thus drawn more closely together for the good of both.

FIG. 26 The "principals" in a dramatic playlet *culmination* of their third grade unit "How Do Insects Help and Harm Us?" These eight-year-old children have created their own costumes representing a mosquito, lady bird beetle, honey bee, flower, caterpillar, and swallowtail butterfly. (*Photograph by the author.*)

Evaluation and Diagnosis

Following the socialized group discussion, the original dramatic playlet, or the culminating gathering which has been given for friends and parents, there follows a brief but important period of formal and informal evaluation. It is interesting and illuminating to know which students have profited most and which least under a given set of schoolroom conditions. If time will permit, a fairly comprehensive program of oral and written reviews may be organized, which will include self-testing upon the part of students. Properly conducted, an adequate testing and evaluating program will attain the status of a constructive and comprehensive *re-*

view, definitely contributory to the science education curriculum. The use of standardized, valid achievement tests at least once each semester is advisable in this connection as an instrument of measurement in terms of grade progression. If the unit is found lacking in terms of basic fundamentals, changes may be made in the future.

Evaluation by the teacher, principal, and supervisors of the results obtained through the study of each unit is important to us, if the fullest advantage is to be taken by all of this reflective period in terms of broad and specific aims. In what ways may motivation, presentation, activities, intercorrelation of allied subjects, and the culmination be improved? Does the bibliography for pupils need amplification? Were there questions left unanswered by the teacher's own book list? Were public relations well handled? Are the achievement ratings as judged by standardized tests all that they should be for the grade level?

An Illustrative Type Science Unit

As a concrete demonstration of unit development according to the eleven factors presented in this chapter, an exemplary outline is now presented. It is to be understood that this is a *type* situation only, similar developmental procedure being applicable to New York City, Boston, New Orleans, Seattle, or any city or county in the country. San Francisco has been selected as a type for several valid reasons. In the first place, the locale is familiar to the author, a Western educator, more so than Boston or New York would be, hence may be more factually accurate in terms of places of pertinent interest and import. In the second place, San Francisco is an important seaport and will fit admirably into the type unit chosen: "Fish and Fishing." Third, San Francisco within itself is both a city and county school system, being a unified district.

Correlation of major and minor units and their indicated position in the superunit child-outgrowth formulation are fully brought out in the outline. Integration of allied subjects

in the "minor" science unit, the use of audio-visual aids, games, and projects, the assemblage of bibliographical materials for pupils and teacher, songs to be sung, and typical arithmetical problems to be solved, together with words to be spelled correctly in unit study, are shown in exemplary detail Lists of problems, projects, spelling words, and similar illustrations are necessarily abbreviated, but will show the *method* to be followed as each teacher elaborates with individuality and interest.

Analysis of the Problem

The *major unit* being studied by most of the pupils of the fourth grade in the type system is "The State in Which We Live." The *minor unit* under consideration for the latter nine weeks of the second semester of the fourth grade is "Fish and Fishing." The students concerned have finished a progressive survey of the home in which they live, with "Gardening" and "Pets" as integrating units, and have studied their expanding environment on "San Francisco Bay" in Grade 2. Grade 3 has been devoted to a survey of "Central Counties, Their Rivers, and Products," and in Grade 4 a state survey is being made, with emphasis upon social studies topics.

The major unit falls naturally into the "child-outgrowth formulation" as a developmental problem, and the minor unit seems indicated for the special consideration of this grade in this particular city because of the strategic location of the school. The age of most of the children is nine; some are ten years old. Coming from families of middle class or better, they are of average or higher intelligence quotient. Curiosity as to the boats which come and go through the harbor is natural at this age, and most of the children have visited the docks and seen fishing craft. A realization of the fundamental importance of this phase of community life is indicated at this time, and the topic offers psychological inducements which make it ideal for the grade concerned. Social science-natural science correlation and integration will

be fostered through the study of this unit at this time, and the children are ready for it.

Location of the Classroom

The type school is Commodore Sloat elementary, situated on Junipero Serra Boulevard, facing the Pacific Ocean near the Golden Gate, in San Francisco, California. The climate is cool the year around, and fogs are prevalent during the summer months, while autumn is warmer, with many sunny days. Children play out-of-doors throughout the year. The neighborhood is definitely middle to upper class, and the school plant itself is modern and up to date in every respect. The children hear the great foghorns near the entrance to San Francisco Bay and see the fleets of fishing boats, as well as tramp steamers, as they make their passage in and out of the narrow 1-mile entrance to the great harbor that is San Francisco Bay.

Grade Level of the Children

The type grade level is the *upper fourth*, finishing a two-semester survey of "The State in Which We Live." All can read extremely well, and writing, oral English, art skills, arithmetical fundamentals for the age level, etc , are much better than average among these pupils.

Availability of Contributory Materials and Information

There is a fine school library Not far away, within easy access by streetcar, bus, or private automobile, is a branch of the San Francisco city library. The Fleishhaker Zoo, well and favorably known throughout the entire Western states, is nearby, and every pupil in the school has been there many times. Of specific interest in connection with this minor unit, the Steinhart Aquarium in Golden Gate Park is also within a short distance of the classroom. Most of the young pupils have visited this famous institution, the finest west of the Shedd Aquarium, Chicago In the old Ferry Building,

at the foot of Market Street, there is an enormous relief map of the state of California, which occupies a spread of perhaps a hundred yards on the second floor. The children have all visited this sectional map of the state during the first-semester studies of this grade.

Inside the Golden Gate, just east of the great bridge, is a small protected harbor for the use of small commercial boats. Here the fishermen bring their boatloads of fish, and here all of San Francisco goes to watch, to see, and to learn about "Fish and Fishing" This is "Fisherman's Wharf," where clams, crabs, and fish of every size and color abound. It is a place of fascination for young and old alike, and children love to go there.

Finally, within the administrative framework of the Unified Schools, embracing both the city and county of San Francisco, there is an admirable division of audio-visual aids, which may be drawn upon as needed for supplementary material usable within the classroom.

Time Allotment

The following outline of timing for the study of this unit is purely suggestive. The teacher will be prepared for any emergency, being able to alter the schedule and plan at any time The degree to which this schedule is adhered will, in last analysis, depend upon the adaptability of the pupils, for individual differences are recognized as the crux of interest and progress.

First Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Motivation	Motivation
Tues.	Appointment of committees	Appointment of committees
Wed.	Audio-visual presentation	Group discussions
Thurs.	Teacher presentation	Group consideration of projects
Fri.	Consideration of projects	Free-reading hour

Second Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Discussion and review	Social science preliminaries
Tues.	Social science	Rhythmics (creative action)
Wed.	Group report: "The Farmers of the Sea"	Class discussion
Thurs.	Group report: "Conservation"	Class discussion
Fri.	Group report: "How Fish Are Caught"	Class discussion

Third Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Discussion and review	Teacher's lecture: "The Economic Importance of Fish"
Tues.	Discussion: "Economics"	Discussion: "Need for Conservation"
Wed.	Music (singing, book, and creative)	Discussion: "Fish as Food for People"
Thurs.	Discussion: "Money"	Spelling
Fri.	Spelling	Spelling quiz

Fourth Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Discussion: "Numbers and Amounts"	Arithmetic
Tues.	Natural science reports on projects	Art: "Form and Colors"
Wed.	Natural science reports on projects	Arithmetic
Thurs.	Natural science reports on projects	Art: "Form and Colors"
Fri.	Group discussion	Free hour

Fifth Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Discussion and review	Natural science projects
Tues.	Arithmetic	Spelling
Wed.	Visiting speaker	Discussion hour
Thurs	Creative art	Rhythmics
Fri.	Health lesson	Spelling quiz

Sixth Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Arithmetic	Arithmetic quiz
Tues.	Natural science projects	Natural science projects
Wed.	Social science discussion	Music
Thurs.	Health lesson	Art
Fri.	Reference reports	Reading

Seventh Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Discussion and review	Spelling
Tues.	Creative art for dramatics	Creative art for dramatics
Wed.	Music for dramatics	Music for dramatics
Thurs.	Dramatics	Arithmetic interlude
Fri.	Dramatics	Group discussion of progress

Eighth Week

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Teacher presentation and review	Natural science projects
Tues	Reference reports	Music for dramatics
Wed	Creative art	Committee work (written)
Thurs.	Spelling interlude	Arithmetic interlude
Fri.	Oral English for dramatics	Creative art for dramatics

NINTH WEEK

	9 to 10 A.M.	10 to 11 A.M.
Mon.	Social science review	Natural science review
Tues.	Written English (invitations)	Music review
Wed.	Art for dramatics	Rhythmics for dramatics
Thurs.	Dress rehearsal	Dress rehearsal
Fri.	Culmination: dramatic playlet	Culmination: dramatic playlet

Basic Objectives

The study of fish and an over-all observation of the fishing industry is fitting for the students of this grade, in this school, in such a type city as San Francisco. The topic lends itself to the educational program and to the survey of the state being undertaken, both from a natural science and a social science point of view. Basic comprehensions to be established include a creative spirit in research, developmental skills in the underlying factors of reading, writing, arithmetic, spelling, rhythmics, art, and oral English. In addition, a primary objective is the encouragement of leadership and self-reliance among the pupils of this grade, which will stand them in good stead throughout their future school lives, as well as in life outside the school. A further aim is the fostering of a spirit of understanding among these young people of the role of science and scientific research in daily life.

Specifically, the study of this unit will contribute to a better understanding of the life of a class of people who contribute in no small measure to the economic welfare of the state. An incidental objective will be to convey a general knowledge, consistent with the limited maturity of the pupils, of the common names, habits, body form, and protective coloration of fishes found along the coast line. Finally, a general knowledge of strange and little-known facts about fishes of the United States and of the world will be presented,

with the aim of broadening the viewpoint and horizon of each of the children.

From the viewpoint of social science, the children will gain insight into the races of fishermen engaged in the industry, the governmental controls set up as conservation measures, and something of the economics of supply and demand, production and distribution of a perishable product.

Motivation Procedure

A preliminary presentation will be made by the teacher. In this presentation he will outline the salient features of the subject, indicating points which he believes will especially interest the particular children at present in the class. The basic objective of this presentation will be to draw suggestions from the children themselves, thus awakening interest in the unit, its problems, and its possibilities. The preliminary presentation, modeled after the lecture-seminar of the training school, may include a discussion of some of the strange fishes of the world, such as flying fish, grunion, angler fish, tree-climbing perch, lungfish, pipefish, sea horses, and the deep-sea forms, together with a discussion of the work of the fishermen who sail their boats in and out of the Golden Gate. Pictures, sample specimens, and model boats will be exhibited. The children will be encouraged to tell of their experiences on family "fishing trips" or of things they have seen on the wharves of the harbor. The room will be decorated with nautical gear, including nets, steering wheels, baskets, fishing poles, lines, and lures, in addition to still photographs (some of them in color) of men of the fishing fleet.

If possible, use of a school bus will be arranged for during the afternoon, at which time a field trip to the famous "Fisherman's Wharf" will be made. The children will be allowed to roam along the area, viewing the many forms of crustaceans and fishes on exhibition. They should be thrilled with the prospect of studying this unit and eager to begin their reading and project discussion through committee se-

lections. During the first week, during the free-reading period, the supplementary text chosen as a correlative reader, *Fish and Fishing*, will be made available. The many photographs contained in this reader will aid in motivation.

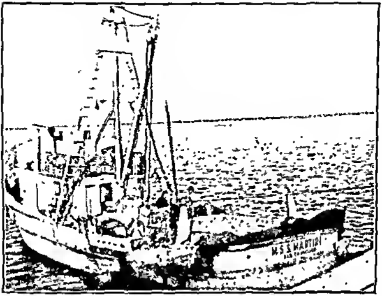

FIG. 27. A commercial fishing boat Field class expeditions to view such pertinent subjects will motivate social studies science integration in the study of the type unit (*Photograph by the author*)

Developmental Activities in the Type Situation

1. *Projects*
   a. Class
      "Make an aquarium" for the classroom.
      Construct a miniature fish ladder.
      Construct a relief map, similar to the one at the Ferry Building, showing the bay, rivers, bridges, and commercial fish harbors.
      Wall friezes.
      Construct a small classroom fish market.
      Classroom museum on fishes and other sea life.

b. Committees

Write and present creative songs and stories.
Work on a dramatic playlet for the culmination.
Give book reports on fishing in fresh-water streams.
Give book reports on fishing in salt-water areas.
Interview commercial fishermen, and report to the class on "The Life of a Fisherman."
Class reports on the following topics:
"Why Fish Are Important to Us."
"How Fish Live in Water."
"Strange Fishes of the World."
"Fish Caught for Fun and for Food."

2. *Reference studies*

How many fish hatcheries are there in California?
How many hatcheries are there in the United States?
How do these conservation agencies operate?
Where does the money come from?
Which fish are used for food by Americans?
Where are some of America's finest fishing grounds?
What fish are caught in each location?
What is a "bathysphere?" How is it used? Who uses it?
Deep-sea exploring.
How should an angler care for the trout he has caught?
What are the "open" and "closed" seasons on various fish?
Who are our commercial fishermen?
What methods of catching fish are there?

3. *Audio-Visual aids*

Motion-picture films:
Let's Go Fishing. Tony demonstrates the right and wrong way to bait hooks and catch fish.
Big Fish. Catching tarpon in the Gulf of Mexico. Hooking a 600-pound tuna. Harpooning a hammerhead shark. Catching salmon in great nets.
Fish. Colored film of tropical sea life.
The aquarium in the classroom will visualize fish facts.
Still pictures and charts. Especially magazine pages such as the *National Geographic Magazine* and the various fish and game magazines. "The Instructor" series 13: Portfolio of pictures of fishes.

4. *Field observations*

Trips will be well planned in advance. Discussion will be held after the initial motivating trip to the Steinhart Aquarium and before and after all other trips.

The following trips will be held by class and committees as opportunity presents itself.

- Steinhart Aquarium (motivation).
- Fisherman's Wharf (commercial).
- A fish market (social science).
- To the Golden Gate (social science).

Integration of Allied Knowledge and Skills

1. *Social science*

Why fish are important to man.

- Fishing brings progress.
- Fish as food since the earliest times.
- Fish economics.
- How many people make their living directly and indirectly through the catching, distributing, and marketing of fish, the manufacture of fishing gear, boats, nets, refrigeration units, etc.
- The canning industry in the coastal regions.
- Fishing as social recreation.

History in America.

- The Scandinavian "Vikings."
- John Cabot's expedition in 1497.
- Coming of the Pilgrims.
- The "Yankee" clipper ships.
- Western explorations of Lewis and Clark.
- The Bidwell party.
- The Donner party.
- Wilkes's expedition (U.S. Navy).
- Frémont's expedition (U.S. Army).

Rise of Western cities through the fishing industry: San Francisco, San Diego, San Pedro, Monterey, Santa Cruz, Portland, Seattle.

Rise of United States cities through the fishing industry: Boston, New York, Baltimore, Miami, New Orleans.

Immigration of fishermen: Scandinavians, Italians, Slavs, Portuguese, Chinese, Japanese.

Governmental control of fishermen and the industry.
Work of the Coast Guard.
Fish and game warden patrols.
Fishing licenses.
Cost.
Duration.
Interstate exchange privileges.
Government hatcheries and other conservation measures taken to ensure supply for all.
Commercial boat registration.
Commercial "catch" recordings.
Legal size and amount limits.

2. *Natural science*

How do fish live?
Life habits.
Body form and structure.
Swimming.
Breathing.
Smelling.
Seeing.
Eating.
Hearing and balancing.
Migrating.
Spawning.
Conservation of natural resources.
Fish as a natural resource.
How the life history of a fish regulates conservation.
Open and closed season regulation.
Relation of water supply to fresh-water fish.
Shasta Dam (Sacramento River).
Friant Dam (San Joaquin River).
Hoover Dam (Colorado River).
Bonneville Dam (Columbia River).
Grand Coulee Dam (Columbia River).
Fish ladders and their operation.
Hydraulic mining and its dangers to fresh-water fishing.
Pollution control.
Refinery waste.
Sewage waste.
Floating and shore fish-reduction plants.

Economic uses of fish.
  Food for other fishes and for man.
    Calcium, iodine, phosphorus, vitamin A.
  Fish-meal fertilizer, dog and cat food, chicken feed.
  Bones as "grit" for chickens, and for glue.
  Carbon dioxide as part of the "balance of nature."
  Fish as pets.
Strange fishes of the world (biological facts).
  Blind gobies.
  Sea horses.
  Nesting fish (dace, sunfish, stickleback).
  Flying fish.
  Dancing fish (grunion).
  Porcupine fish.
  Air-breathing fish (Dipnoi).
  Tree-climbing fish.
  Angler fish.
  Electric fish.
  "Four eyes" (air and water vision).
  Archer, or "spitting fish."
  Shark sucker.
  Pilot fish.
  Hawaiian head fish.
  Deep-sea fish.

3. *Oral English*
  Group discussions in class.
    Students learn to speak of what they have read and seen.
    Develops self confidence, vocabulary, diction.
  Individual presentations of special topics.
  Reading aloud.
  "Verse-speaking choir."

4. *Spelling*
  Words connected with the unit which may be new:
    Aquarium
    Hatchery
    Ladder
    Conservation
    Species
    Spawn
    License

Hydraulic
Gills
Fins
Pollution
Fingerling
Sacramento
San Joaquin
Columbia
Colorado
Mississippi
Missouri
Ohio
Gulf of Mexico
Atlantic
Pacific
Migration
Mollusks
Crustaceans
Scandinavians
Portuguese
Italian
Fish names, such as mackerel, dace, grunion, salmon, trout, shark, cod, herring.

5. *Reading*

Choric verse (verse-speaking choir) in groups.

Poetry. Such selections as the following:

Verses for Children
"The Lobster."
"The Little Fish That Would Not Do as It Was Bid."

Treasury of Verse for School and Home
"Little Ships in the Air."
"The Wreck of the Hesperus."
"The Sea."
"The Ships."
"The Fishermen."
"The Three Fishers."

Current-event reading, pertaining to the fishing industry. Magazine articles and newspaper items.

Reports on books.

Silent free reading[1] from class references and supplementary special readers, such as *Seashore Life* and *Fish and Fishing*.

6. *Writing*

Creative writing.

Poems, stories, and little dramatic playlets.

Keeping a "diary" of class and individual activities.

Penmanship improvement.

Invitations to the "culmination" to parents, friends, and principal.

Writing thanks to visiting speaker.

Writing thanks to curator of Steinhart Aquarium for allowing visit.

Elementary experience in "taking notes" on speakers.

7. *Arithmetic*

Use of the constructed miniature fish market within the classroom will give the pupils practice in making change with money. Addition, subtraction, multiplication, and division may be dramatized in this way.

Construction of the fish ladder will give practice in the use of ruler and yardstick. Emphasis upon accuracy in measurement will be an indirect gain through this activity.

Problems of the following types may be utilized:

Joe went fishing with his father. The first day they caught eight fish. The second day they caught five fish. The third day they caught ten. What was the average number of fish caught?

If a female salmon lays 30,000 eggs in one year, how many eggs would she lay in three spawnings?

Susan bought 5 pounds of herring at 30 cents a pound. How much money did she pay?

Mary and her father caught 25 pounds of fish. Mary caught 5 pounds. What fraction of the total did Mary catch?

If a barracuda swims 100 yards in ten seconds, how many yards does it swim in one second? How many feet does it swim in two seconds?

[1] Typical of the many excellent publications designed for child learning about nature in the Cornell Rural School Leaflet series is: Palmer, E. Laurence, "Fish Bait," *Cornell Rural School Leaflet*, Vol. 43, No. 4, Spring, 1950.

Jack bought 25 pounds of ice to keep his fish in. One-fifth of the ice melted before he got home. What fraction of the ice did Jack have to use on his fish?

If a fishing boat is 42 feet long and 10 feet wide, how many square feet are on the deck of the boat?

The price of sardines is $35 a ton. How much are 500 pounds worth to the fishermen who catch them?

Dr. Beebe took his famous "bathysphere" down to a depth of 3,028 feet in the year 1934. How many feet short of one mile is this?

Yellow tuna sold for $400 a ton last year. If a fishing crew caught 20 tons, and their expenses were $1,000, how much did the crew make on this trip? If there were seven members of the crew, how much did each man make?

8. *Art*

The class, through committee allocation of duties, will construct a large frieze around the room illustrating various types of fish caught near San Francisco Bay.

Models of fishing craft will be made from clay.

Fish pictures will be drawn and colored.

Scenes of boat traffic on the bay and through the Golden Gate may be drawn.

Illustrations for original poems and stories will be drawn.

Charts will be made for use in committee presentations.

Costumes of fishing folk will be made for the culmination.

Perspective will be gained through scene sketching.

Color and form will require close inspection and reference work.

9. *Music*

Music appreciation will be an objective. Records such as the following may be used on the classroom phonograph:

Sea Murmurs (Victor V1645)
The Oceansides (Victor 11935)
The Sea (Victor 21396)
By the Sea (Victor 7473)
Reflections in the Water (Victor 6633)

The children will compose *original songs*. They will prepare their own music and words. These will be used in the culmination as deemed fitting.

Songs for group singing will be selected from such sources as the following.

Our Land of Song, C. E. Birchard Company, Boston.
"Our Covered Wagon Days."
"Sea Gull."
"Fearless Fishers."
"I saw a Ship go Sailing."
"Rushing River."
"Ride a Sea Horse."
"Sacramento."
"Over the Bright Blue Sea."

Songs for Children, American Book Company, New York.
"Silver Fish."
"The Sea Princess."

Songs, Hall, McCrary and Company, Chicago.
"Sailing."
"Tugboat."

Songs of Travel and Transport, Neil A. Kjos Music Co., Chicago.
"Row, Row, Row Your Boat."
"I Wish I were a Sailor."

Work and Sing, William R. Scott, Inc., New York.
"The Bold Fisherman."
"The Boating Song."

10. *Rhythms*

Records will be played, and the children will listen. There will then be a period of *interpretation*. Or, if desired, interpretation may be *creative as the music is played*. In general, it is best to play the piece at least once before interpretations are made. This gives genuine "feel" for the rhythm.

Creative interpretations may be made of such inspirations as:
"The Rolling Waves."
"A Fishing Boat at Anchor."
"The Sea Wind."
"A Storm at Sea."
"Sailing Home."
"Gliding Golden Fish."

Dances will be arranged, informally creative, and formal. Either or both types may be selected for use in the culmination.

Rest periods are indicated, as health intervals and as inspirational periods.

Games of low organization may be included in the rhythmic program. Some selections from the more formal types are given here.

"Catch of Fish," Mason and Mitchell, *Active Games and Contests*.

"Fish Tag," Mason and Mitchell, *Active Games and Contests*.

"Ocean Is Stormy," Mason and Mitchell, *Active Games and Contests*.

"Crab Walk," Neilson and Van Hagen, *Physical Education for Elementary Schools*.

"Sailboat," LaSalle, Dorothy, *Rhythms and Dances for Elementary Schools*.

"Sailor's Hornpipe," Burchenel, *Dances of the People*.

11. *Health*

Care of the classroom aquarium, providing proper light, water, and food for the fish, will provide direct health transfer motivation. Children will learn about sanitation and hygiene. Study of fish as food will provide materials for the students' developing interest in their own bodily health and welfare. Discussions as follows:

Calcium, phosphorus, sodium, vitamin A, and iodine, are substances provided in large measure by fish. Fish is a good food to build resistance to colds. These chemical elements, of course, are beyond the province of Grade 4, but the children may be taught health without knowing all the details, *viz.*, "Fish is not a brain food, but eating fish is one way to keep healthy and strong."

Fresh air, good food, regular sleeping habits, clean water sources—all may be brought about through the study of this unit.

12. As a culminating activity, a *dramatic playlet* may be presented by all members of the class. This may have scenes depicting fishermen mending their nets, getting ready for their fishing trip; setting their nets while at sea, hauling in the nets, returning to port with the "catch," and setting the fish ashore in the harbor. Music, rhythms, language arts, creative art, and all integrated activities will be interwoven by teacher *and* pupils. This will include the handwriting of invitations, decoration of the schoolroom,

exhibition of work done during the unit period, as well as preparatory rehearsals of the dramatic presentation.

The Culmination

As indicated above, the original dramatic playlet organized by teacher and pupils within his classroom is perhaps the best form of culminating activity. It will be remembered that a successful culmination teaches through demonstration and subject review, as well as interests the children. The culmination of our type unit will take as its theme, "A Night in Port." It will include:

Demonstration of notebooks and creative art.
Presentation of folk dances of fishermen's native lands.
Reading of original poems and stories by members of the class.
Singing of suitable songs, chosen by the children in advance.
Serving of tuna salad on crackers by class members to guests.

The playlet, "A Night in Port," will be a production in several scenes, the fishermen telling their friends on shore of their life at sea while fishing, how they prepare for the voyages, how they spread and haul in their nets, and how they bring their fish to market. All scenes and creative interpretations are to be originated and integrated by the children themselves. Parents, friends, newspapermen, and school administrators are to be invited to attend and are to be welcomed at the door and seated by class committees.

Evaluation and Diagnosis

Following the culmination will come a period of sober evaluation and judgment of activity worth and means of improvement. Formal tests and informal discussions among the children will be undertaken. Spelling mastery, arithmetical mastery, and reading mastery for the grade level must be indicated, or remedial means resolved upon.

The Children will be asked to state:

"What I liked best in studying this unit."
"What I liked least in studying this unit."
"How I think our studies might be improved."

The Teacher will consider, with his principal and supervisor:

Was the unit technically successful? Did the children show definite growth curves?
What weak spots developed?
Has a sound basis for further study been provided?
Did the unit satisfactorily integrate with the major unit?
Has the unit stimulated a desire to continue such study among the children?
Have public relations been favorable? Was there a good attendance at the culmination? What comments did the parents make?
Weighing results against objectives and aims, what improvements may be made the next time this unit is studied at this grade level?

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Problems for Group Discussion and Review

1. Why is careful planning necessary in undertaking the development of a unit of study?

2. List the ten steps considered essential in unit development.
3. What is a major unit? What are minor units?
4. What relation has the city in which the child lives to the study of any given unit?
5. What relation has the county in which a child lives to the study of any given unit?
6. What relation has psychological age to unit development? Just what is meant by "psychological age?"
7. What relation has previous study to a unit? What relation has later study in subsequent grades have to the unit?
8. Where will you look for teaching aids in unit development? What help may you expect from what sources?
9. Discuss the problem of sufficient time for unit development.
10. How would you go about the problem of interest motivation?
11. What types of projects are best suited for individuals? For committees? For the class as a whole?
12. Show how the socialized discussion enters into the picture.
13. What elementary subjects are most useful in unit presentation and development? Which two are most widely used by teachers? Why?
14. Show how various subjects may be integrated into the activity program.
15. What steps do you consider the most valuable in undertaking an evaluation of the unit program and a diagnosis of its faults and good points?

Chapter 9. DEPARTMENTALIZED SCIENCE IN GRADES SEVEN AND EIGHT

Whether considered as the terminal grades of the elementary sequence or as an integral part of the junior high school, the seventh and eighth years of school life stand at the crossroads of American education. This is the turning point for thousands each year who plan to leave school and enter fields of business. Students are reaching or have already reached a critical stage in their physical development, and associated with this is a series of psychological tensions which educators may not safely ignore. To meet these conditions, special administrative and teaching techniques have been developed in this field.

Before considering science education as a specialized phase of the general problem, let us briefly summarize the fundamental aims of student education at these grade levels. There are two groups to which the curriculum must be adapted. Theoretically, students comprising these basic divisions should undertake quite different lines of study, since their life plans and needs vary so greatly in terms of future use of content materials. The first class of students intend to leave formal schooling and "get a job" as soon as the compulsory education laws will permit. The second class intends to continue on through the senior high school, a few of this group planning to go to college.

In practice, however, it is noted that no such heterogeneous condition exists, for students do not fall into one category or the other. Boys and girls, in a large percentage of cases, do not know just what they intend to do. They are confused in their own minds by wishes of parents, advice of teachers,

and immature counsel of friends. *Guidance* is a real problem at this age, even when attempted by thoroughly experienced administrators, for many complex factors enter into each student profile. In our survey of science education we must continually bear in mind the basic nature of these influences, molding them to help rather than combat educational progress. The teacher of seventh or eighth grades thus faces an unusually challenging pedagogical problem, having a curious cross section of youth in his classes. In making home-study assignments, in planning laboratory or field work, in counseling each student, he must balance psychological and sociological factors with subject progress, interest, and aptitude. The extent to which this is done often determines the degree of success or failure.

Methods of Attack

Administratively, as has been outlined previously, there are several basic plans for the educational sequence at this crucial educational level; 8-4, 8-1-3, 6-3-3, and 6-4-4 plans are most common, the latter being observed in but a few urban centers which run junior and senior high together, and where the secondary work is carried on into the junior college The term "elementary" is generally taken to include the first eight grades, whether incorporated in a 6-3-3 junior high school plan or as a terminal unit within itself.

Science is presented in a variety of profile forms, as might be expected from such a widespread variance in administrative plans; the science curriculum varying from one year to three, depending upon organization, content, availability of trained personnel, and number of periods per week apportioned for science study In some urban and rural systems the grade sequence of unit study is continued on into the seventh grade, the eighth being devoted to the physical sciences, while the ninth is devoted to personal hygiene and health; while in others this eighth and ninth sequence is reversed. Some teaching bodies feel that best results are derived from health and hygiene in Grade 7, with "general" science spread over the next two years.

Recently a feeling has become general nationally that general biology (stressing interdependence of the physical and life sciences in environment) may well be set down one year from the tenth grade of the senior high school, where it has traditionally been offered. This procedure would present a unified science program offering personal and civic health and hygiene in the seventh, physical science in the eighth, and general life science in the ninth grade. The latter provision seems to the author to embody many desirable points. Among these may be mentioned the fact that previous training in science having been given steadily throughout the elementary grades, students may not only be ready, but in many cases anxious, to enter upon detailed study of specific subjects in approximately that order. The arrangement would allow the election of social (human) biology in the tenth, chemistry in the eleventh, and physics in the twelfth grade of the senior high school,[1] with provision in some centers for optional study of botany and/or zoology in the upper division of the high school.

College entrance requirements as to chemistry and physics in the secondary school leave few optional selections in the science field for the college-preparatory group, but a previous year's study in ninth-grade environmental life science will allow the student and his advisers to determine with some degree of assurance which path shall be trodden. The ideal junior high school science sequence, then, appears as follows:

Grade 7

Personal and Community Hygiene, involving such phases of elementary physiology as are necessary for the understanding of the functions of the human organism and hygienic life in a democratic social community.

Grade 8

General Science, with stress upon physical factors in the environment. These will include a conception of matter and

[1] Refer to Chap. 5, The Child-outgrowth Formulation.

energy, air, water, electricity, sound, heat, light, interdependence, physical geography, transportation, and improvements for better living.

Grade 9

General Life Science, required of all students, as are the other previous sciences. This course in the last year of junior high school, or the first year of the four-year high school, will stress environment and ecology, while serving to unify the students' previous conceptions of chemistry and physics obtained in *Grade 8*. Interrelationships of the living and nonliving world and their interdependence will be the theme. This requirement of general life science in the ninth grade will make possible the planning of social or human biology on such a basis, which in terms of secondary science is in itself a highly desirable objective.

Viewing the science sequence from the elementary terminal seventh- and eighth-grade class position, as contrasted with the junior high school plan, the sequence recommended above will still be found most effective, with the same factors influencing judgment as before In the seventh grade as well as the eighth, however, there is a decided inclination among modern educators to favor *departmentalization*[1] of subject matter instruction. The young students concerned react best to this form wherever it has been instituted, as the method tends to bridge the gap between the lower and higher grades. The subject matter is factual and should be taught for its own sake as a concrete body of knowledge, integration with other subjects proceeding continuously just as if departmental instruction were not in force. As has been mentioned, departmentalization necessitates "teamwork" in presentation, especially in the seventh grade, in order that transition shall be orderly and gradual and that there may remain the greatest possible cohesion and unity in attack, each subject and teacher reinforcing the other.

[1] Chap. 2, Trends and Methods.

PERSONAL AND COMMUNITY HYGIENE

To summarize the scientific facts concerned with human welfare learned in the previous grades, to coordinate acquired health habits with personal and civic betterment, and to emphasize the economic value of "a sound mind in a sound body" are the prime functions of an adequate course in seventh-grade hygiene. Teaching must be adapted to an age level of twelve to fifteen years, a unique problem in itself. Boys and girls find themselves extremely sensitive and self-conscious, developing various "complexes." The psychological problems arising from contacts made during this transition period may be studied advantageously through the medium of personal and community hygiene, for the child has acquired considerable background of experience and reaction already. His chief interests center about his home, his friends, and himself. Motivation, so difficult to secure in other departmentalized subjects, is natural and unaffected in so far as it results directly or indirectly from these interests in life.

Why teach *hygiene* in the *seventh* grade? Because at this point each young person has greatest need for information about his or her body and its care, and at this point training in citizenship is needed to ensure future intelligence in civic enterprises. Sex matures early in some girls, who are at this age considerably more interested in the boys than the boys are in them! Lipstick, powder, rouge, high heels, and costume jewelry enter the picture, and an alert hygiene teacher can turn these inclinations to good advantage in terms of personal grooming and good taste. Among the boys, the "gang" age rears its ugly head, and physical qualifications are all-important in creating group leadership. Here again the sound, strong young body, muscular and held erectly in response to posture training and knowledge, may replace the slinking gangster type into which young boys so readily metamorphose themselves unless clever teachers intervene. This is the period when a young person *needs* to know hygiene, both

personal and community, for his own sake and for the sake of his family, as well as for the betterment of the community in which he lives and in which he will mature to become a voting citizen.

Interests: Home, Community, School, Extracurricular Activities

The interests of young boys and girls at this age are not distributed evenly over all fields of endeavor, but rather are concentrated on certain familiar features of the individual's environment. His point of view includes things, places, and people which are familiar to *him*, for his circle of friends is still quite limited and regional. His acquaintance with environment from personal knowledge has normally been limited to his home, his community, his school, and the people he has met there, plus occasional family trips to summer resorts at the beach or mountains. These in themselves have an almost personal attraction for him. His home is better than the other fellow's. His school is far better than any other in the town, and the fellows and girls who go there are far superior to those attending other schools. His town is a better town than any neighboring town; his state is a better state than any other; his country is far superior to any other. All these feelings are deeply rooted psychologically and sociologically in the child's previous training and emerging personality, and the intelligent teacher of the seventh grade will capitalize upon them in directing work centers of interest.

The *home*, of course, has the greatest influence on the child. It offers a logical starting point in generating enthusiasm for individual investigation in elementary hygiene. The cellar, the attic, the front porch, the living room, the barn, the bathroom, the kitchen, the garden, the sidewalk, the street gutter, all offer problems for study in relation to improvement and hygienic maintenance. The sunroom, the kitchen, the laundry, and similar places so familiar in the home offer

veritable science laboratories in themselves. The child, the home, the family, and the community are integrated in the environment both at school and at home.

The local *community* offers a further field which is eagerly investigated by young students of community hygiene. Gas and water supply, public drinking fountains, sanitation, hospitals, fire department, restaurants, theaters, parks, swimming pools, and playgrounds are examples of units of civic interest. Why is the town in which the boy or girl lives a good place in which to live? Individual and group investigations in this field are too obvious to need amplification at this point and will be given full rein by the alert teacher.

The *school* itself has become a motivating director of the youth's activity. Home and community investigation are stimulated and planned here. The playground, gymnasium, garden, and library, as well as the heating, seating, ventilating, water and food supply systems, provide materials for immediate investigation and reports. The people within the school are of importance to the young person, although perhaps he himself does not know it. Classmates and friends, and teachers also, provide interest centers which the child tries to "play up to" and to subconsciously imitate. Loyalty is developed at this stage beyond any other, and a spirit of cooperative helpfulness may also be encouraged. This is the "gang" age; the age of furtive glances and ruby lips; the plastic age of impressions and of quick action and reaction. This is the time an urge to "belong" sweeps each young heart until each boy or girl feels the gregarious urge to *join* something, to create, to excel others in doing things.

Extracurricular activities now become almost a mania with many young people, and science educators will take advantage of this surging instinct. School health and hygiene should be closely correlated with Boy Scout and Girl Scout programs, with Junior "Hi-Y," Boys' Club, and Junior Red Cross training, as these educational developments exert

powerful influences for good among preadolescent young people. The scouting idea, for example, associates learning with altruistic idealism in a most appealing manner. The scout learns to swim and to perform artificial resuscitation not only as a physical accomplishment per se, but in order that he may be prepared to assist in saving the life of a fellow human being He studies bird lore in order that he may really know harmful from beneficial birds The scout-instructed "fireman's lift and carry," methods of binding splintered limbs and pulled muscles, and proper use of practical antiseptics become an established part of the youth's practical knowledge of hygiene. These things and dozens of procedures like them are learned not because some teacher insists upon it for itself alone, but in order that as a scout he may "Be Prepared." It is this idealistic trend which has lifted scouting to such a successful place of eminence in dealing with young people, and good teachers of seventh-grade hygiene recognize its assistance in building character as well as in aiding in the education of the whole child.

The place of natural science in the scout training program may be elaborated upon, for definite steppingstones along the path to knowledge have been worked out in practical application of the sequence plan. The girl scout, for example, must be able to tell others about an animal or a pet in order to pass from a "tenderfoot" to a "second-class" rating. In order to advance further, she may be required to pass an oral examination on any three of the following subjects: birds, land animals, water animals, trees, wild or cultivated plants, insects, or minerals. If additional topics are mastered from this list, the second-class scout may become an "observer," with merit badge. A "first-class" scout must be able to locate a certain tree, flower (garden or wild), land or water animal, or a definite bird, insect, rock, or star. If two additional are found as directed, the first-class scout becomes a "rambler," with accompanying merit badge. A "naturalist" girl scout has become proficient, through ap-

proximately a year's study, in gardening, zoology, bird study, entomology, theory and practice of farming, beekeeping, geology, or astronomy as subject fields. It will readily be seen that such a program of nature and science intercorrelation generally will be of inestimable help to teachers of seventh- and eighth-grade science. Bodily health and moral courage being watchwords in boy and girl scouting, the home, the school, and the community are aided in the teaching of personal and community hygiene as with all forms of science education.

Health as an Objective

Health studies are not only undertaken with the aim in mind of training young people in proper living before fixed bad habits have become permanent, but with the further aim of interesting them as young citizens in the public welfare of the community. Structural form, or human anatomy, should be taught only in a general manner at this age level, brought in as an adjunct or basic foundation for hygienic thought. Sometimes teachers deaden the science instruction at this stage through excessive use of terms and detail. General health lessons for themselves alone are the province of the seventh-grade work; leave the detail until later studies in anatomy and physiology, as indicated in the education of trained specialists.

Health is each person's birthright, and most people would be quite healthy throughout life if proper attention to health rules and hygienic care were emphasized in the education of everyone. This is the objective of the seventh-grade course: to train future adults to *think health* and to practice health training for individual and group welfare. The teacher will allow his students to *convince themselves*, through individual and class investigation of applied problems, that it is through the careless breaking of health rules that a great many if not most diseases arise. One of the country's greatest medical authorities, a former president of the American Medical

Association, has stated simply that just "washing the hands thoroughly before each meal" is perhaps the greatest single aid to good health and happiness known! Apply these things in daily contact, and seventh-grade hygiene becomes a joy to teach, an evangelism in enmity upon the forces of ignorance and disease which can make each teaching day a triumph, instead of a drudge. This is true of all teaching at all grade levels, but it is especially true of the socialized class in hygiene. All factors converge to create an opportunity for genuine creative progress and vitalizing influence upon the very lives and well-being of students.

Preachment and rote learning of physiological rules and trite truisms are far from adequate teaching at this age. Boys and girls must practice body care, actually forming and confirming good health habits and becoming crusaders for the cause of community health and happiness. An uncovered sneeze in a crowded place becomes a minor crime; to spit upon the theater floor is unthinkable. Contrast these reactions with those of the usual sordid influences which make themselves felt in even the most remote towns and school centers, and the virtues of such teaching and training are apparent. Show your students *why* you wish them to learn certain features and facts; convince them as to the practical application to family happiness and welfare as well as in their own daily lives, and you will have little difficulty in obtaining concentration Boys and girls of this age assimilate readily enough when they are brought to a realization of the essential personal and family group benefits of hygienic facts and health information.[1]

Content as Means to an End

Departmentalized seventh and eighth grades differ markedly from those of the previous elementary levels in the use of definite courses of study and texts designed to

[1] See *Teaching about Cancer*, American Cancer Society, 1950. Address in Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters.

give instruction in a specific subject field. The main body of subject matter to be gone over with students is rather clearly defined, several excellent texts being available for use both in hygiene and general science. In the most modern textbooks in these fields the unit plan is carried through in problem form, subjects being divided into unit problems, continuing the unit-activity program as carried on through the previous elementary grades. Content is stressed in Grades 7 and 8, however, with activities being limited to individual and committee work in investigating specific related problems. Detailed content outlines are administered in most of the progressive systems, thus bridging the gap between the upper elementary grades and the four years of secondary work.

The mental discipline involved in organization of content material with students becomes an important part of preadolescent training. Motivation, as we have stressed, centers about the personal interests of the student. The learning process then becomes a more personal matter with relation to health and hygiene, dependent upon the cooperation of the student rather than the teacher. Content, then, should be presented so as to stimulate independence of thought and creative action, appealing to the unique interests of young people. If this is done, it becomes a means to a desirable end, equipping students to take their places in life, enjoying good health, and surviving contact dangers, while bringing about mutual civic cooperation and responsibility.

It may be well at this point, in view of the more definite nature of content presentation in the seventh grade, to present a semidetailed outline of a typical course of study for use as an illustrative form, which may be altered and supplemented by each teacher as suitable to the specific school and community situation. A course of study developed by the author in teaching seventh-grade health and hygiene will serve this purpose.

An Outline for the Study of Hygiene

A. Personal Hygiene

1. What and how do we breathe?
   a. Atmospheric conditions. Variation according to altitude. Variation according to location at similar altitudes. Smoke. Dust. Fog. "Smog." Relative humidity. Ventilation.
   b. The human breathing apparatus (charts and diagrams). The larynx, trachea, bronchial tubes, lungs, diaphragm, and their functions in normal breathing. The normal rate of human respiration. Relation of respiration to circulation of the blood. Why do we breathe? "Fresh air." Methods of artificial respiration.
2. What should we eat, and why?
   a. Proper preparation of foods as a domestic and commercial science. Nutrition and health. Principles of cooking by various methods (frying, boiling, baking, toasting, etc.)
   b. Content of foods.
   Proteins (examples of animal and plant types).
   Carbohydrates (examples of animal and plant types).
   Fats (examples of animal and plant types).
   Vitamins, what they are and why important.
   Minerals, what minerals are needed in diet.
   Roughage and bulk.
   c. The water we drink. Where does water come from? Why do human bodies "get thirsty"? Comparison with other animals and with plant tissues.
   d. The human digestive system. Diagrams and charts to illustrate the general anatomy of the human alimentary canal. Studies of the mouth and teeth. Care of the teeth and gums. The stomach and its work. Hygiene of restful, quiet eating. Necessity for regular habits of food elimination. Causes of constipation. Causes of "upset stomach" and "acid indigestion."
3. Hygiene of the eyes.
   a. General structure of the human eye. Comparison to a camera. How we "see." "Farsightedness" and "near-

sightedness." Astigmatism. Causes of blindness. The work of the optician. Types of lenses used to correct eye faults.

b. Care of the eyes. Motion pictures, when, how often, how long. Reading and studying. Principles of good room illumination.

4. Hygiene of the ears.
   a. General structure of the human ear. Comparison and contrast with the ears of other animals. How we "hear." The inner ear as a human organ of balance. Comparison with balancing reflexes of other animals, vertebrate and invertebrate.
   b. Care of the ears. Cleanliness. Avoidance of sudden loud noises. Never "box" a child's ears! Swimming and diving. Aids for the deaf and partially deaf.
5. Hygiene of the nose and throat.
   a. General structure of the human nose and throat. Charts and diagrams. Why we breathe through our noses. Mouth breathing. Tonsils and adenoids. Deviated nasal septum. Remedial surgery.
   b. Care of the nose and throat. "Nose drops." Inhalations. Proper use of the handkerchief. What is a "cold"? What are "allergies"? Gargling. Occupational hazards. The nose and throat as focal points of bacterial infection. Prevention of respiratory diseases. Sun-bathing and fish-liver oils. Clothing.
6. Hygiene of the bones and muscles.
   a. Structure of the human skeleton (general terminology). Diagrams, charts, and a human skeleton are desirable. Good and bad posture at work and at play. "Brace up and you won't run down!" Proper shoes for care of foot bones.
   b. Location of some principal body muscles and their work. Exercise and "keeping fit." Strength, a mental as well as a physical asset. Muscular tone as aid to general health. Relaxation and play. Rest and sleep. "Voluntary" and "involuntary" muscles. Proper clothes for work, play, and relaxation.
7. Hygiene of the nervous system.
   a. General structure of the brain and central nervous system. General functioning of the sympathetic nervous

system. Good nerves help maintain good health. Causes of headaches. Worry and its effect upon the sympathetic nerve control system.

b. Mental hygiene or "attitude." Smoking: What are the facts?

8. Hygiene of the skin, hair, and nails.
   a. General structure (charts and diagrams).
   b. Cleanliness. Types of baths. Baths versus showers. Creams, tonics, shaving, "make-up." Biting versus cutting nails. Soaps and oils. Making a habit of neat personal appearance.
   c. What relation does personal appearance have to success in life?

B. Community Health and Hygiene

1. The general principles of public health. Mutual cooperation. "All for one and one for all." Are you your brother's keeper? Why study community hygiene?
2. Source of the community water supply.
   a. Where our water comes from. Treatment in processing for human consumption. Who does all this? Why? Reservoir protection.
   b. Watershed tree and plant conservation measures. Contamination control at the source. Pipe-line aeration. Analysis, chlorination, filtration, "softening."
3. Hygiene of water use.
   a. Drinking fountains. Types, good and bad. "The old oaken bucket." The community "tin cup." Being a good citizen at the drinking fountain, at home, and in the theater or any public place, including school.
   b. Swimming pools. Dangers of nose and throat infection. Sinus irritation. Chlorination. Swimming under water. Staying a long time under water. How far can you swim under water? Discussions of real physical dangers involved.
4. Community sewage disposal.
   a. Various community disposal methods.
   b. Sewage a serious community problem. Possibilities of epidemic.
   c. Why seventh-grade students should know about sanitation. Bond elections and voting campaigns.

5. Community garbage disposal.
   a. Various community disposal methods.
   b. Garbage disposal a community problem. Possibilities of epidemic. Hygiene of garbage disposal in the home, at school, in restaurants.
   c. Why seventh-grade students should know about garbage disposal.
6. Community health and recreation.
   a. Trees, parking areas at sides of streets. City parks.
   b. Why plants are helpful to man in maintaining health.
   c. City recreation facilities. Playgrounds, lakes, tennis courts, etc.
   d. Cooperation with the playground supervisor or recreation director.
7. Municipal health projects.
   a. Vacation camps for citizens in mountains, seashore, river, and lake country. Value of outdoor life.
   b. Tuberculosis preventoria. The work of the "preventorium." Who goes there? Why? When? Is it a shameful thing to go?
   c. Sanatorium locations for tuberculosis. Rest and good food. Possibilities for recovery. Maintenance of a happy outlook and confidence in the future. Tuberculosis hygiene.
   d. Mental hospital locations. Possibility for cure. Worry and strain versus happy mental hygiene.
8. Contagious and infectious diseases.
   a. Explanation of the difference. Why these things are important.
   b. The common cold. What is known about the common cold today. Economic loss suffered through absence and more serious complications which sometimes result. How one "catches cold." Theories and facts. Preventive measures. Predisposing anatomical causes. Treatment measures in cold hygiene. Keeping up general body resistance through proper food, rest, cleanliness, and fresh air. Avoidance of fatigue. Isolation.
   c. Influenza and pneumonia. Epidemics of "flu." Types and treatment by medical authorities. Do not treat serious cases at home, but "call the doctor" if cold

seems bad and there is a temperature or serious chill. Isolation for community welfare.

d. Typhoid fever. Milk supply relationship. Medical treatment and public health prevention.

e. Smallpox. Vaccination for prevention. The story of Edward Jenner. The "great plagues" of former centuries.

f. Diphtheria. Toxin-antitoxin treatment in medicine.

g. Scarlet fever. Symptoms and medical treatment outlined.

h. Whooping cough. Formerly very serious. New, early preventive treatment.

i. Tuberculosis. Dangers of contamination.

j. Malaria. Public mosquito control. DDT.

k. Poison ivy and poison oak as community problems. Killing sprays.

l. Measles and mumps. Community measures of control.

m. "Athlete's foot," a fungus plant infection. Methods of prevention. Home remedies. Medical help for severe cases.

n. Impetigo. A serious school disease under epidemic conditions. Home remedies. Isolation and quarantine as a community measure. How to recognize impetigo.

o. Ringworm. A plant fungus, not a worm! Treatment measures. How to recognize ringworm.

9. The work of the health officer.
   a. City health officer and his work.
   b. County health officer and his work.
   c. Supervision of milk, water, food supply. Regulation of sewage disposal. Pest control. Citizen cooperation.
   d. Traveling health clinics and X-ray units.
10. Food and drug laws.
   a. National, state, and local regulations and their enforcement.
   b. Laws and cooperation for the common good.

General Science

Following the science sequence for Grades 7 and 8 as detailed earlier in the chapter, the last year of the elementary

school will be utilized in broadening the student's outlook in the phases of science which appear to have the greatest everyday application in preparation for life in the United States today. In view of the sequence progression, physical science factors will take precedence in this grade over those of the life sciences, since a great many subjects remain for

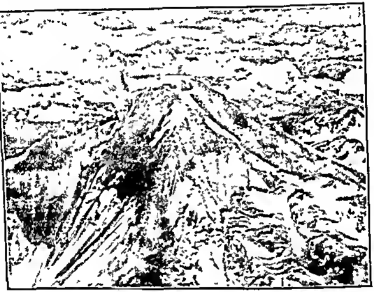

FIG. 28. Study of the *earth* is important in general science. Smoldering fire under ice and snow is shown in this aerial photograph. Notice the column of steam rising from a fissure at the left center and a smaller column on the ridge near the center. The location is Iliamna volcano, Alaska. (*U. S. Air Force photograph*)

study which the child has not been able to cope with heretofore because of immaturity. *Astronomy*, touched upon in the sixth grade, will have opened new fields of investigation and wonderment which may be explored with intellectual profit in the eighth grade, although the study of the stars is not strictly of practical application in the daily lives of students. Practical carry-over value may be shown even in this through reports on weather and climate as affected by seasons, the tides, navigation principles, and elements of meteorology. Astronomy will stimulate interest in weather and climate.

Weather and *climate* will certainly be studied at this grade level, for wind, clouds, rain or lack of it, floods, dust storms, air pressure, use of thermometers and barometers, reading weather maps, and a general training in practical weather forecasting are all of immediate interest and worth in terms of training for life. Climate will lead to a general study of *physical environment*, including *geology* and *land forms* as a basis for *physical geography*.

Matter and *energy* are basic topics which the child has not been mature enough to master until this age, and these will lead some students far into basic science. Principles of energy sources, transformation, and conservation will form interesting unit centers. Air and water, elements and compounds in nature, electricity and magnetism, all are divisional topics. How each is used for the betterment of man and how misuse may operate for the hindrance of man's progress form supplementary units.

Demonstration teaching may well replace some of the older-type student experimental periods in some phases of general physical science presentation. Experiments and controlled studies made upon absorption and fact assimilation have shown rather conclusively in recent years that for students of this age one carefully and skillfully performed demonstration is more adequate than many individually "bungled" work-desk projects. The very best students will want to do both! A clear discussion and careful summary of results and conclusions will be found to be as good or better, in many situations, than excessive duplication of procedure by many students, many of whom do not truly understand the nature of such study and lack initiative and manipulative skill to perform work of this type well.

In the eighth grade, demonstration teaching conforms especially to studies in *applied chemistry* and *physics*. In this connection it must be limited in presentation to *fundamentals* and not get too far into technology at this time. The elements and some of their properties may be studied, together with the elementary mechanics of compound forma-

tion; but it is of extreme importance to remember that these are very young and immature pupils who will not, and cannot, master more than a superficial acquaintance with these topics. Most of the early mistakes of "general science" teachers have been traceable to an overzealous application of the *instructor's* college courses in chemistry at this level. This erudite privilege is perhaps the tradition of the young Ph.D. in college freshman chemistry instruction (and sometimes not only observed in the young); it has no place in dealing with boys and girls in the eighth grade. Appreciation, as is well recognized, may well be killed through monotonous bewildered drudgery and simple lack of comprehension. Let the *spirit* rather than the letter of chemistry pervade the classroom at this point. Let the result of chemical research speak for themselves in revelation. The eleventh and twelfth grades offer further paths to learning in the physical sciences.

To a somewhat lesser extent, the same admonitions apply to the science of physics as it is incorporated within the eighth-grade elementary science course; applied experimental results rather than the techniques of accomplishment being brought out. We are living in the dawn of a great scientific age, and elementary young people will realize this if attention is paid to results of physical science research. It is truly enlightening to consider the inventions and discoveries which have come into everyday use within the last hundred years or so, and these will form the background in physics for the wise general science teacher. The sewing machine, the steam engine, the telegraph, the telephone, the phonograph, the electric light, submarines, gasoline engines, machine guns, airplanes, radio, X rays, radium, motion and sound pictures, color photography, television, polarized light, air conditioning, plastics, radar, and atomic energy release, are a few examples of pertinent investigation topics which will form the nucleus of the really functional course in eighth-grade science.

Electricity, with its resultant heat, power, and light, will form another segment of general physical science. Here again

a knowledge of control is paramount, practical results of electrical engineering being of foremost interest. Application of electrical energy in the production of "work" in the physical science sense of the term will be brought out in many ways, leading to a preview of future potential in the field of electronics.

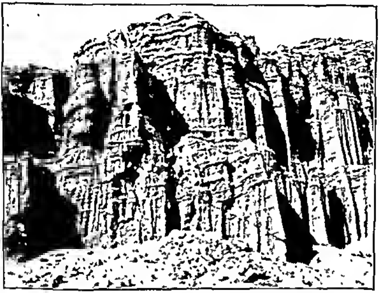

FIG. 29 How the earth's surface changes, a general science topic The crack which may be seen running from the upper left to lower right in the photograph reveals a weakness in the geological strata along which movement may have taken place Large scale movement of this type produces what is known as an "earthquake." (*Photograph by the author*)

Study of the *earth* itself will form a part of the course, wherein the basic fundamentals of geology, mineralogy, and physical geography will be introduced. Knowledge of "land forms" will be of lasting interest as the young student enters adolescence and begins to travel for himself. Forces which have brought about changes in the earth's surface in the past, and which will continue to produce changes in the future, must be understood. Field trips to points productive of

interesting geological strata will be of value here. Leading from this study, the student naturally becomes interested in soil and in soil conservation, which will lay the foundation for future studies in social biology.

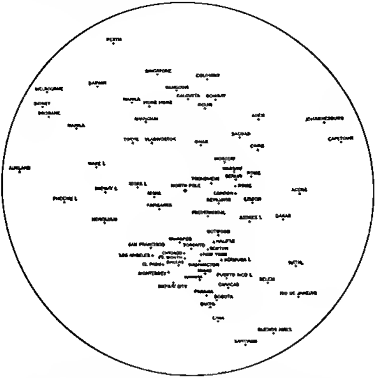

FIG 30 An *air map* of the world. Transportation by air brings a new conception of world geography. (*Courtesy of American Airlines, Inc.*)

Transportation improvement will be studied in considerable detail in the eighth-grade course in general physical science, culminating in speculation on the present and future potential of *air transport*[1] in terms of supercharged cabins,

[1] See United Air Lines (School and College Service) and other sources in Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters. State the grade level for which the material is desired, and the type of class project.

jet propulsion, and supersonic speed. In no other field of science is the door of opportunity open wider for practical research than in aviation engineering, and much may be done by the eighth-grade teacher in revealing horizons.[1]

The study of "general physical science" then becomes one of groundwork laying in the larger sense, rather than rigidly applied instruction in techniques. *Revelation* is the keynote. Students, as has been brought out earlier, are at an extremely impressionable stage of physical and mental development. The greatest good, as elementary science sequence culminates in eighth-grade studies, may be accomplished in feeding and stimulating this scientific curiosity; in providing intellectual stimuli for further studies among the above-average students, while giving general comprehensions to those who cannot themselves create. Appreciation of the efforts, objectives, and attainments of scientific research for the betterment of man is the basic objective.

Problems for Group Discussion and Review

1. Discuss the specialized problems of the seventh and eighth grades from the viewpoint of psychological reactions.
2. What subjects and topics outside of the classroom interest young people of junior high school age?
3. In what ways do you think various psychological and physical maturity factors may be utilized in furthering science education?
4. In your teaching position in a junior high school, what science sequence will you recommend? Why?
5. Show several reasons why a departmental organization works most effectively in Grades 7 and 8.
6. Discuss the aims, content, and sequence of topics in a seventh-grade departmentalized course in personal and community hygiene.

[1] Tuttle, Frederick M. (Ed.), "Air Age Education in the Elementary School," *National Elementary Principal*, Vol XXVIII, No. 3, December, 1948.

7. How would you vary or improve upon the type of course of study offered in the chapter as an example?
8. Show how the school can cooperate with the home in building a better citizen through the study of hygiene and community health.
9. Outline the content of a good eighth-grade course in general physical science.
10. Discuss course content as "means to an end," with specific relation to the elementary terminal course in general science.

Chapter 10. THE JUNIOR HIGH SCHOOL SCIENCE LABORATORY

EQUIPMENT

Science instruction in seventh- and eighth-grade laboratories necessarily utilizes more technical equipment than was needed in the lower grade elementary classrooms,[1] because of comparative student maturity and the exploratory nature of the experiments attempted. A few compound and binocular demonstration microscopes are required for the study of unicellular life, which is normally taken up at this time. For general science, the simplest microscope which will stand up under hard and often inconsiderate usage and neglect, but which will offer the desired magnification, should be adopted. There is no need for advanced microscope construction at this age level; indeed, curious novices would soon find ingenious ways to disarrange such mechanisms. Leaders in the field of school laboratory equipment, such as the American Optical Company (Spencer), E. Leitz, Inc., and the Bausch and Lomb Optical Company, have perfected ideal instruments for such use in hygiene, general science, and in eighth- or ninth-grade biology laboratories

A "demonstration eyepiece" is a good investment. With this eyepiece, which is so adjusted that two persons (pupil and instructor) may look through the microscope at the same time, much time may be saved and practical instruction given. A pointer is provided for use by the teacher, and the entire instrument may be removed and carried to the next microscope, temporarily replacing the regular eyepiece of

[1] Chap. 4, The Elementary Classroom Laboratory.

each student's instrument. A "camera lucida," while not actually necessary, is a comparatively inexpensive piece of scientific equipment which has an excellent use in exciting curiosity and stimulating interest, since its uncanny ability to reproduce figures invisible to the naked eye on paper is always productive of a chorus of exclamations among junior high school pupils who watch it demonstrated.

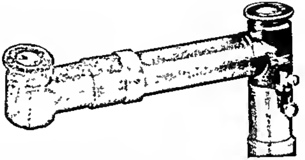

FIG. 31 The *demonstration eyepiece* is an excellent aid in science education in departmentalized laboratories where beginning instruction with microscopes is undertaken Both instructor and pupil see the same object on the microscopic slide at the same time (*Courtesy of Scientific Instrument Division, American Optical Company.*)

Every well-equipped laboratory designed to train young people for further scientific studies in high school should have at least one binocular demonstration microscope for the examination of larger objects and specimens. Geological and mineralogical specimens in *general science* are particularly adapted to such study, as are the various forms of chemical crystals. *Hygiene* classes find many uses for such an instrument, too. A noninverted image of the stereoscopic type, an extremely wide field, and a variety of objective adjustments are features of this educational tool.

A "balopticon" or "delineascope" is a *must* for science education in the upper elementary grades. There are two general types of these instruments; one which is used from the rear of the classroom or from a laboratory table to project book pages or 3¼- by 4-inch slides[1] on wall or screen,

[1] Refer to Part II, Resource Aids: Audio-Visual Sources of Supply.

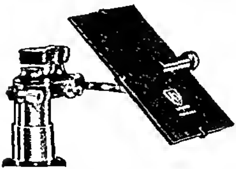

FIG. 32 A *camera lucida*, used in making accurate reproductions of microscopic subjects. (*Courtesy of Scientific Instrument Division, American Optical Company.*)

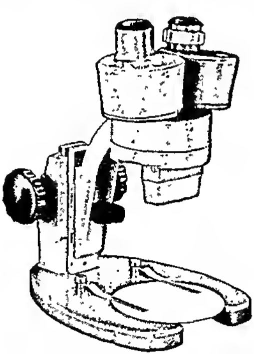

FIG. 33. A stereoscopic wide-field binocular *demonstration microscope* of the type recommended for use in junior high school laboratories. (*Courtesy of Bausch and Lomb Optical Company.*)

and one which may be used by the instructor while facing the class. By means of the latter type, not only the glass slides may be projected, but linear drawings on ground glass or even entire visual experiments may be performed, such as a demonstration of magnetic lines of force. Efficiency in science instruction and classroom control are objectives.

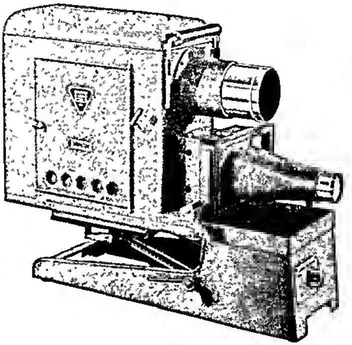

FIG. 34. A "balopticon" *opaque projector* of the type recommended for use in junior high school laboratories. (*Courtesy of Bausch and Lomb Optical Company.*)

A microprojector, important as it is in college teacher-training laboratories, is not generally found to be justified at this lower grade level. The use of the "microtome" with this type of class is not recommended, even when the instructor is relatively skilled in its use. Time spent in running original materials through technical processes may far better be employed in more practical ways. University-trained bi-

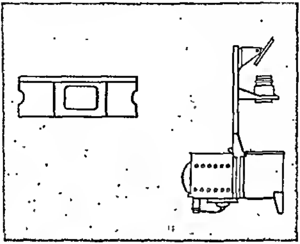

FIG. 35. An upright "delineascope" projector, used in lecture demonstrations as the instructor faces his science class. (*Courtesy of Scientific Instrument Division, American Optical Company.*)

ologists who expect to do effective work with young people must turn from manipulation of paraffin, acidulated carmine, 95 per cent alcohol, and kindred carry-overs from upper division classes in microtechnique to more extroverted demonstrations of content materials.

Where and when some simple dissection is indicated, such as small-frog gross anatomy, wax-bottomed pans may be purchased at slight cost from laboratory supply companies.[1] Most of these have metal rings at the corners for tying specimens in place. A single pair of bone scissors for the laboratory will suffice, since what little of this type of work is given will be in the nature of demonstration. Large forceps will be found useful many times during the school year for removing preserved specimens from deep containers and in handling struggling live forms. Women teachers will find rubber gloves of material assistance in preventing the crinkling action of formalin solutions upon the skin of the hands.

Simple dissecting instruments may be provided for student use—scissors, small forceps, dissecting needles, scalpels, and small rulers being sufficient. A cross-cut saw, hammer, pair of tin shears, glass cutter, screw driver, and a chisel will be found useful many times during the school term in carrying out class and individual projects. Specimen jars of various sizes and types must be included, enough of these being provided for student as well as for teacher collections. Both three-cornered and rattail files should be in the toolbox.

Chemical apparatus for eighth-grade departmentalized science will include plenty of test tubes, Bunsen burners, rubber tubing, clamps, burettes, pipettes, filter papers, litmus papers, asbestos sheets, wire screens, laboratory safety matches, earthenware jars, tube cleaners, fishtail attachments for burners, porcelain dishes, and other paraphernalia needed for simple chemical experiments, as desired by the instructor. Chemical supplies will include acetic, dilute nitric, and dilute hydrochloric acids; with sulfuric housed in a

[1] Refer to Part II, Resource Aids: Supplies and Apparatus for Departmentalized Science.

locked cabinet, where its use for demonstration purposes may be supervised. Limewater, sodium hydroxide, and ammonium hydroxide solutions, iodine, xylene, and Fehling solutions must also be available. Carbon tetrachloride will be safer to provide than ether or chloroform, except for demonstration work. It is a much safer insect anaesthetic, and should be so used by both teacher and students.

In the solid group may be included the starches (corn, rice, wheat, potato), the sugars (sucrose, lactose, fructose), soluble egg albumin, water-soluble eosin, marble chips, and charcoal. A large jar of white vaseline and a small container of mercury are often useful. Sodium bicarbonate is another functional solid. It is, of course, quite evident that these paragraphs cannot encompass in complete detail all the supplies and equipment necessary for each and every science experiment, but enough is given to allow the instructor to build for himself in the laboratory.

Zoological supplies for general science classes will include a few insect nets, although the comic-book notion of the science teacher and his youthful charges chasing elusive butterflies over the landscape has long been passé. Drying boards for straightening out insect wings and bodies, glass-covered mounts of the "Riker" type in various sizes, and large containers for the storage of specimens will be needed. Do not overlook a plentiful supply of 40 per cent formaldehyde for making "formalin" preservation fluid: a solution of 1 part formaldehyde and 10 parts water. Glass specimen jars in various sizes, cotton, cheesecloth, plaster-of Paris demonstration mounts of animals and animal organs for demonstration, and specimen preparations for classroom and museum exhibition are other items.

Botanical supplies useful in the science classroom include sawdust, flowerpots, plant trays, germinating pans and/or tables, together with plant presses equipped with large blotters in quantity for pressing flowers, leaves, and terrestrial and aquatic plant specimens. Bell jars of various sizes are often made use of in plant studies. Glassware, including

beakers, funnels, test tubes, holders, racks, and brushes for cleaning, pipettes, medicine droppers, rubber tubing, and cork sheets will be found about as useful and necessary in the experimental study of plant life in the general science course[1] as in the chemical phases of the work. A portable fire extinguisher and a first-aid kit must be in every science laboratory.

The arrangement of the junior high school laboratory with relation to *spacing* and *lighting* varies with the type of subject matter to be presented. For plant experiments[1] the classroom is best located with southern or western exposure to provide maximum winter sunlight for the growth and well-being of plants during experimental demonstrations. If it is possible to provide a glasshouse or a lathhouse adjacent to the laboratory itself, as is done in many modern junior high school plants, such an arrangement is, of course, ideal. North light is best for microscopic work and for drawing studies of all types, unless artificial lighting such as fluorescent or other indirect illumination is provided. In a few exceptionally well-equipped laboratories, substage illumination is provided for microscopic studies, just as in many university botanical laboratories.

Laboratory tables should be rather wide to provide space area for books, binders, handbags, and personal wraps not stored in hallway lockers. Roomy tables are an aid in maintaining discipline, for demonstration of plant and animal specimens, and for experimental "setups." Table tops must be of comparatively hard wood and surfaced to prevent erosion from chemicals and physical wear. Sinks and plumbing are necessary for general science work, but sometimes classrooms contain too much sink and water area for effective study. If the plumbing areas are concentrated on one side or on special tables, the area may be supplied with running hot and cold water, gas outlets, and AC and DC electric current. At least one large, deep sink with a wide drain outlet

[1] See Chap. 11, Laboratory Experiments with Plants.

is of special usefulness in the laboratory, allowing for the washing of specimens, cleaning of equipment, and flushing out of dissections. Provision for such cleaning activities distinguishes the neat and orderly laboratory, for young students cannot be expected to keep a clean room without functional provision for such cleanliness.

Utopia

Is all this equipment essential to good intermediate grade science teaching? Such *utopian* conditions may be built up over a period of years, but the beginning teacher is not likely to find them in his first school. There can be little doubt that plentiful equipment and a lengthy list of supplies smooths the path, but much can be done in science education without materials and supplies in great abundance. The author is a firm believer in adaptation to circumstances in teaching as well as in other forms of human endeavor. If a young teacher, fresh from his teacher-training laboratories (perhaps tax supported and luxurious in all manner of equipment) does not find conditions in the junior high school laboratory exactly as he would like them, he need not lose hope. Many finely equipped laboratories totally lack the real spirit of scientific endeavor, while even a small unpretentious room may fairly radiate it! *The difference lies in the spirit of the teacher.* Take the situation as you find it; then set to work exercising your own initiative and ability to build therefrom a laboratory of which both you and your seventh- or eighth-grade students will be proud.

This spirit of cooperation and adjustment to circumstances is a bit of educational philosophy which the teacher will do well to assimilate early. It is agreed that proper equipment and enough of it for each student to work with is necessary and to be insisted upon in Grades 11 and 12, especially in the study of chemistry and physics. Competent and adequate work in the college-preparatory field cannot be accomplished without it, but much may be done with com-

paratively little in seventh- and eighth-grade science, especially in connection with the plant-life demonstration experiments so widely used today.

Of course, this cooperative counsel does not imply that the young instructor should assume a beaten, cringing attitude in requesting supplies, but rather realization and careful consideration of budgetary limitations, amount of money available, and expected use in recommending purchases. If plenty is available, well and good; if little, the capable teacher will give instruction as well as he knows how with what he has, building patiently but steadily toward the future.

Attention to the aesthetic environment will do a great deal to lighten the psychological load imposed by close budgeting. Maintain the symmetry of your room. Keep it balanced. Open windows to approximately the same angle and draw curtains to the same height. Keep your workroom neat and clean. Wastepaper on the floor is appreciated by no one, and ink spots on white-enameled sinks stimulate little but the accumulation of more ink spots! Neglect of these seemingly unimportant details often mars the effect you seek to create, and certainly a laboratory neglected in this way does not convey a sense of serenity or inspiration.

In the life science laboratories, thriving aquaria, as nearly balanced as possible, should be prominent. "Guppies" and goldfish in proper environment are always interesting. If you are fortunate enough to be near the seashore, a salt-water aquarium will be a source of unfailing interest. An "aquarium pump" electric aerator is an essential if the animals are to remain alive long, for such aquaria are notoriously difficult to keep. Plants may be used to brighten any schoolroom. Ask each student to bring a potted plant and to be responsible for its care. It may surprise you, for most of them will do it! Experiments with plants, which occupy an important place in the science curriculum, are themselves of interest.

In the general science laboratories of the junior high school

we may typify the spirit of accomplishment and industrial research which pervades modern chemistry and physics. A radio, a phonograph, and even a television set, if financially possible, are helpful for special occasions. There should be workable table models illustrative of the laws of leverage and gravity, and electric signs that *light*. Student-made charts showing chemical processes and the modern products resulting from them, particularly the isotopes; photographs of famous chemists together with a summary of their achievements, and photographic views of present-day manufacturing chemists' laboratories all add to the businesslike and purposeful atmosphere of the schoolroom and inspire students to scientific endeavor. Projection equipment for audio-visual instruction is essential in the modern general science classroom.[1]

Not long ago, while visiting a junior high school in a thtiving industtial town, the author was struck by as nearly perfect a general science laboratory as has been his privilege to enter. Plants, animals, and industry-simulating physical science experiments were everywhere! Running water trickling musically into little realms of life—aquaria balanced and quietly beautiful with rear illumination. Large glass cages filled with strange creatures from various parts of the world, at which one lingered long. It was a Saturday morning, nevertheless the instructor was there bustling about in his miniature universe. Work, drudgery, routine? Simply unknown This science teacher was finding genuine happiness in the creation of something functionally worth while in the lives of his students. Teaching is a real joy to him, and his laboratory a never-to-be-forgotten experience for those fortunate enough to cross its threshold [2]

[1] Shambo, Mildred, "Audio-Visual Teaching Aids in a Science Curriculum," *The Science Teacher*, Vol. XVII, No. 1, February, 1950.

[2] To join with other junior high school teachers of science in the furtherance of nationwide science education, write for membership in the *National Science Teachers Association*, 1201 Sixteenth St., N.W., Washington 6, D.C. Service to you includes the valuable "Packets of Science Information for Teachers."

Do eighth-grade students really appreciate such effort? Do they actually enjoy thinking and working in such an atmosphere as this ideal environment you are urged to create? *Shh!* Here comes "Wild Bill" Smith—red hair, freckles, and all! Watch him He breathes deeply as he comes through the door, looks around him, and *smiles!* "I like to come to this class," he remarks "Somehow it's different from any other period of the day. Doesn't seem so much like school."

Here is your chance, instructor. The stage is set; ennui and blasé boredom have been cast aside. He has dropped his protective mantle of sophistication. His guard is down. *Strike!*

Problems for Group Discussion and Review

1. What part does physical environment play in the general educative process?
2. To what extent should the junior high school hygiene and general science laboratories contribute toward psychological conditions favoring a scientific attitude of mind?
3. Prepare a floor plan for an ideal laboratory for teaching junior high school science.
4. Prepare a detailed list of apparatus and equipment you would need for the giving of adequate instruction in junior high school physical science.
5. Make an accurate list of companies from whom you might expect to order such apparatus, listed in problem 4.
6. Prepare a detailed list of apparatus and equipment you would need for the giving of adequate instruction in junior high school hygiene and life science fundamentals.
7. Make an accurate list of companies from whom you might expect to order such apparatus, listed in problem 6.
8. List supplies you would need in order to effectively teach (*a*) general science and (*b*) personal and com-

munity hygiene. From what companies might you order such supplies?

9. Which directional natural sunlight exposure is best for botanical studies? Why? Which is best for microscopic studies? Why?
10. Visit one of the commercial nurseries or a plant supply store. Obtain a list of plants which would grow well indoors in your community.
11. What is meant by a "balanced" aquarium? What lessons may be derived from attempts to set one up in the laboratory?
12. Evaluate the demonstration method and the experimental method, as applicable to junior high school instruction in seventh- and eighth-grade science.

Chapter 11. LABORATORY EXPERIMENTS WITH PLANTS

Seventh- and eighth-grade departmentalized science should contribute much toward the well-rounded socialized development of the adolescent. Despite the present widespread trend in favor of teacher demonstrations, we must remember that young people learn by "doing" in this as in other phases of education. Proper mingling of actual "feeling of the soil" with field excursions and library reference work will inculcate in each individual the spirit of scientific observation and research. Actual skill in following the "scientific method" will be a desirable result of teacher adaptation of materials presented in this chapter.

While working with young students in setting up such experiments as those presented here, we must remember, first, that these are "type" problems, individual plant examples being interchangeable in various sections of the country; and, second, we must bear in mind that faulty techniques are almost inevitable if we are to let eighth-grade students perform experiments for themselves. Mistakes will be made and will be repeated; but if the teacher persists, he will provide a basic groundwork which will remain with his young charges for many years. Records of experiments attempted, reasons why they were selected for trial, results obtained, and conclusions drawn up by the individuals or groups concerned should be kept for reference. It will be best if the teacher will discuss these things with his students and encourage them to keep observational records for themselves in notebook form, thus emphasizing neatness, orderliness and scientific accuracy.

In organizing a program of experimental studies in terms of plant life, the author endeavors in this chapter to present many of the classic experiments, somewhat modified, as foundation for and freely dispersed with problems based upon the teacher's local situation, offering adaptation possibilities in this way. Some problems may be performed as demonstrations, some in group collaboration, and some as individual studies bringing out basic principles.

Introductory Problems[1]

Preliminary Observation of Living Plants

1. Introductory field survey of local flora.

2. During the laboratory period following the field excursion, oral discussion of the points observed will be followed by a written description, to be entered in the laboratory notebook under the title "Plant Associations."

The teacher will take the group out of the classroom on a "nature walk," visiting a park, if rural tours are not convenient, or simply making a tour of the school grounds. In calling the attention of your students to the living world about them, note groupings, vertical and horizontal zonations, coloration, typical formations, and general associations. Do not lecture formally or permit questions to lead to involved or technical discussions Too much subject matter at this stage will serve to discourage rather than to stimulate Your primary objective should be to center the attention of students upon plant study, awakening individual interest.[2]

[1] Pupil directions as given in this chapter are indicative only, and are not intended for direct presentation to classes The capable teacher will utilize the form, adapting actual directions to his individual laboratory situation.

[2] See Zim, Herbert S, Martin, Alec, and Nelson, Arnold L., *American Wildlife and Wildlife Plants*, McGraw-Hill Book Company, Inc., New York, 1950.

What Local Facilities Aid Botanical Study? (Homework Assignment)

Visit the school and town libraries, parks, museum of natural history, and one of the local commercial nurseries. Prepare a report, to be entered in your science notebook, summarizing what material you found of botanical interest.

The instructor will assist in tabulating the results of your local explorations on the board. The purpose of this exercise is to aid in the solution of your future investigations by indicating where you may obtain source material and additional information.

How May We Determine the Presence of Organic Compounds?

Starch. Dissolve a very small amount of wheat starch in water, warming in a "test tube" over the "Bunsen burner." When this bit of starch is dissolved, add a few drops of iodine solution. What color is this iodine solution? What happens when it comes in contact with the starch solution? Repeat with corn, potato, and rice starch, using very small amounts as before. Try the test with plain water, using a fresh, clean test tube. Why? What conclusion can you draw from the results observed?

Protein. Dissolve a small amount of egg albumin (dried) in water, warming and shaking. Pour off some of the dissolved albumin into another test tube, as the test is easier with clear liquid. Now add to this liquid a few drops of dilute nitric acid. (*Caution!*) What happens? Now add several drops of ammonium hydroxide. Result? Touch drops of concentrated nitric acid and ammonium hydroxide to the finger tip. What occurs? Can you explain why? Clean up apparatus, using a test tube brush to remove the residue of albumin. Conclusion?

Sugar. To a small amount of grape sugar add enough water to dissolve (about ½ inch in the bottom of a test tube should be sufficient). Now add *equal amounts* of Fehling No. 1 and No. 2 solutions. Note colors of each of these solutions

and the color of the resulting mixture. Now *heat to boiling*. Describe the final result in your notes.

Repeat this experiment using one of the starches instead of sugar. (Use clean, fresh glassware, spoons, etc., at every stage). Explain the results obtained in this case. What conclusion may be drawn from these experiments?

Fats. Rub a walnut or a peanut on a piece of brown wrapping paper. Hold the paper up to the light. Result? Conclusion?

SOILS[1]

Do Soils Vary in Weight and Structure?

Obtain from the school grounds or nearby territory samples of gravel, sand, clay soil, and garden loam. Measure about ½-pint portions of each and weigh. Record your results in tabular form Conclusion? Examine as to texture and describe differences you observe. Conclusion?

Do Soils Vary as to Chemical Content?

Examine the samples of scientific farm and garden fertilizers exhibited in the laboratory. (The instructor will provide commercial samples.) Note the variation in texture and in the content as given in the chemical list on the labels. Make a list of the chemical contents of each fertilizer. Gather what information you can from parents, friends, and acquaintances on the use of various fertilizers in the soil of your community. Have you a farmer friend? Ask him about the use of fertilizers. Look up soils and their contents in various references available in the laboratory. Do soils vary chemically? Are there special "acid" fertilizers?

[1] The laboratory library will be supplied by the teacher with booklets and pamphlets adapted to the grade level concerned. Examples as follows: Parker, Bertha M., *Soil*, Basic Science Education series, Row, Peterson & Company, Evanston, Ill., 1943; Swift and Company, *The Story of Soil*, Agricultural Research Dept., Chicago 9.

Do Soils Vary in Water-retention Power and Capillarity?

Obtain samples of gravel, sand, clay, and garden loam as before. Line four glass funnels with filter paper as demonstrated by your teacher (fold twice, crease, moisten, and place in position) Arrange funnels in filter stand. Fill each funnel with one of the soils. Place glass beakers or other receptacles beneath the funnel stems. Now rapidly pour over each a measured equal amount of water. Which soil allows water to pass through it the most rapidly? Which soil retains water the longest? Record results.

Now empty the funnels, line with fresh filter paper, and fill with the soils as before. Place simultaneously in full beakers in such a way that water reaches up to the soil contained in the pointed filter paper. Observe to see which absorbs the water upward (capillarity) the most rapidly, which the next, and so on. Record results. What conclusions can you draw from this experiment?

Does Soil Contain Acid?

Moisten a piece of blue "litmus" paper with distilled water, then touch it with a drop of dilute acid. What happens? This demonstrates a test for the presence of any acid.

Moisten a fresh piece of blue litmus paper and cover with moist soils of various types. Is the presence of acid demonstrated in any of them? Do you think that the presence or absence of acid would in any way affect the growth of plants? Do you know of any garden plants which *like* an acid soil?

What Effect Has Acid upon Rock?

Put a few drops of dilute "hydrochloric" acid (the reagent bottle marked HCL) on chips of commercial marble which you have placed in a small dish. Note resulting "effervescence." Watch for some time, adding more acid occasionally. What happens to the marble chips? What relation has this to the occurrence of acid in soils and the crumbling of rocks in nature?

OPERATION AND CARE OF THE COMPOUND MICROSCOPE[1]

The microscope, to which modern science is indebted for much of our present biological knowledge, was invented by Ganseen, a spectacle maker of Middleburg, Holland, in 1590. Galileo, a famous Italian scientist, together with Hooke, an English professor credited with the discovery of cells, made fundamental improvements in the instrument and were among the first to use it scientifically The progress of optical science has brought many changes, of course, until today the microscope is the powerful ally of plant and animal physiologists in their ceaseless struggle against ignorance and disease

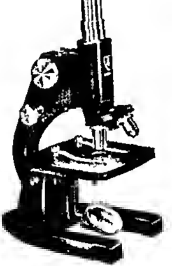

FIG. 36. A modern student-type monocular *compound microscope* for use where electric laboratory desk outlets are not available or when reflected natural illumination is desired. (*Courtesy of Scientific Instrument Division, American Optical Company*)

The microscope consists in part of an "eyepiece" at the upper end of a long "focal tube." At the lower end of this tube are two "objective lenses," so called because of their relative position near the object to be examined. The objective lenses rotate on a swivel mount, so that each may be separately brought into line with the eyepiece. The entire focal tube (bearing eyepiece and objective lenses) may be raised or lowered by means of large and small wheels, known as the "coarse" and "fine" adjustments, re-

[1] This material may be given in lecture-demonstration form by the general science instructor, or it may be assimilated through study and direct observation. This is basic groundwork subject matter and should be carefully supervised to assure mastery.

spectively. These may be operated from either side of the instrument.[1] Below the coarse and fine adjustment wheels is a slightly curved handle supported by a "base" which bears the platform, or "stage." This stage, which is made of noncorroding material, is perforated by two small holes in which "clips" are inserted to hold the glass slides used for microscopic examination. There is also a larger central opening, the size of which may be regulated by a shutter "diaphragm" located beneath the stage or by a circular substage wheel with openings in it of various sizes for optional use.

An adjustable mirror[1] extends below the microscope stage, which directs light upward through the opening in the middle of the stage. Between the handle and the base of the instrument is an "inclination joint" which may be used to adjust the body tube at just the right angle for comfortable study.[2]

Correct manipulation of the compound microscope distinguishes the careful student of hygiene or general science. The first requirement is good, glareless illumination. North light is best, if artificial or the newer substage illumination[1] is not used. Students should practice looking through the eyepiece with both eyes open, since this method is used by scientists because it is less tiring. Always focus with the "low-power" objective lens (the shorter one) first, by placing this lens in line with the eyepiece, at the bottom of the body or "focal" tube, and using the coarse adjustment wheels to place the low-power objective lens in position about ¼ inch above the microscopic slide being examined. Then, looking through the eyepiece, move the focal tube upward, turning the "coarse adjustment" toward you until the object is in

[1] The latest type compound monocular microscopes eliminate focusing with the fine adjustment wheels and have direct substage electric illumination of the proper intensity built into their bases. In most schools of the range covered by this book, however, standard-type microscopes will be used by students.

[2] The teacher should send for laboratory wall charts identifying microscope parts, and "test your knowledge" seat-work fill in charts, from one of the optical supply companies listed in Part II, Resource Aids: Supplies and Apparatus for Departmentalized Science.

general focus with the low-power lens. Next, using the "fine adjustment," bring the object exactly into focus for your own eyesight. If observations are to be made with the high-power objective lens, swing it into line with the eyepiece and focal tube after preliminary observation with the low-power lens. It will be found to be practically in focus and readily adjustable with the fine adjustment wheels.

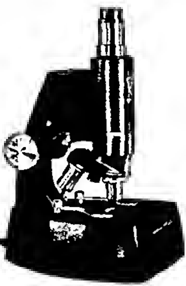

FIG. 37. New type compound microscope for use in hygiene and general science laboratories of the departmentalized school. Features are an elimination of the fine adjustment wheels and the substage mirror and inclusion of built-in electric base illumination (*Courtesy of Scientific Instrument Division, American Optical Company.*)

Never focus downward with the high-power objective lens, as it may crack the cover glass of the slide, which barely clears the lens tip when in focus.[1] When examining a subject brought into focus by another student, never place your fingers on the large coarse adjustment wheel and attempt to

[1] The newest type microscopes have built-in "stops" which prevent this slide-cracking, long a troublesome factor in departmentalized science teaching in the upper elementary grades.

focus. This faulty technique is common among beginning students and usually throws the entire subject out of vision range. It is very *good* technique, however, when approaching another's microscope, to place your fingers lightly on one of the *fine* adjustment wheels. Manipulation of the latter compensates for the slight difference in eyesight between various individuals.

Proper care is essential in order that the microscope may be maintained in good order. Always carry the instrument by the handle, preferably resting the base in your other hand. Never attempt to carry more than two microscopes at one time. Do not swing the microscopes when walking, since one may strike the sharp edge of a desk, resulting in injury to expensive lenses. Never pick up a microscope by the tube near the eyepiece and attempt to walk away with it grasped in this manner, for it may fall apart. Avoid sudden jars, such as placing the instrument on a laboratory table with undue force. When examining wet slides (mounts made in the laboratory using water and cover glass) do not use the inclination joint, since water may run off the subject on an inclined stage, allowing it to dry prematurely. When using prepared slides of sealed variety, however, the microscope may be tilted to any desired angle permitting easy vision and good illumination.

If, through accident, balsam or oil adheres to objective lenses, stage, or slide, these substances may readily be removed with a cloth moistened with "xylol." Alcohol should not be used, since it may remove the glossy finish of the microscope. Always put your instrument away in its case or cover it with a flannel cloth. Prevention of dust accumulation is important for accurate microscopical study and research.

One of the greatest achievements of modern optics is the Harvard microscope. This remarkable precision instrument is relatively as powerful in ultramicroscopic perception as the great 200-inch Palomar telescope is in reaching out into the infinite. Using electric focusing motors, microphotographs of objects much smaller than the wavelength of light

are made. One of the most powerful magnification instruments in the world today, however, is the "electron" microscope developed in the laboratories of the Radio Corporation of America.[1] Its magnifying power (25,000 times) is several times that of the best light microscopes.

What is the Nature of the Plant Cell?

According to the theory advanced by Schleiden and Schwann in 1839, now universally accepted as fact, all plants are composed of units called "cells." The living material contained within the walls of these cells is termed "protoplasm." All life is composed of this substance. It *is* life! Under the microscope a denser, more granular portion may usually be distinguished in studying the cell. This is the "nucleus," which functions during the reproduction of the cell, containing all the characteristics of the cell within itself. That protoplasm between the nucleus and the cell is distinguished by the scientific term "cytoplasm." These names are not too difficult to learn, and they are used so often in the various books that it is well to understand what they mean. The cytoplasm contains food used by the cell and disposes of the poisonous wastes accumulated within it by means of bodies termed "vacuoles."

Have ready a clean glass slide and cover glass. With scalpel and forceps (furnished and use demonstrated by the instructor) strip off a bit of tissuelike living membrane from the inner surface of an *onion* scale. Place carefully on the coverglass. Examine under the low and high powers of the compound microscope. Describe in your notes the appearance of the cells seen under each magnification, observing their general shape and arrangement. Can you distinguish the cell walls, the nucleus, and cytoplasm? Make careful drawings of several cells. How does the length compare with their width?

[1] The instructor should send for informative materials. See Part II, Resource Aids: Booklets, Pamphlets, Pictures, and Posters.

Some cells contain color bodies in the cytoplasm. To see these, cut a very thin "cross section" from the wall of a *green pepper* fruit, supplied by the instructor. This section must be extremely thin, hence is best done with a small razor blade. Mount a semitransparent bit on a clean slide and cover with cover glass. Study under the low and high powers of the microscope. Can you distinguish green color bodies?

Seeds

What Should We Know about the Structure of Seeds?

Seeds are so economically important to man and other animals as a source of food as well as plant life, that a knowledge of their composition seems fundamental if we are to study plants. The instructor will emphasize and explain the important terms used in your textbook in the study of seeds. If we understand what these words mean and how the structures referred to function, we shall better understand the structure of various kinds of seeds. Several types of soaked and dry seeds are available in the laboratory for study. Obtain examples of each, together with instruments needed for this study, from the teacher.

Seed Types

Peas. Examine dry and soaked specimens. Note the difference in water content in the soaked peas. Locate the *testa*, *hilum*, and *micropyle* externally. Make an enlarged drawing of the external structure, labeling the three structures identified. Dissect to locate the *cotyledons*, *plumule*, and *hypocotyl*. Note that the pea is a "dicot." Note that there is no *endosperm*, the necessary food being contained in the large cotyledons. Sketch to illustrate the internal anatomy. Label your sketches carefully.

Beans. Lay one of the soaked beans on its side, so that the hilum faces the left edge of the drawing sheet and the micropyle is toward the top of the page. Sketch and label. Slip off the testa and hold it up to the light. Can you dis-

tinguish signs of veining? Does the hilum scar extend through the cotyledons, or does it mark only the seed coat? Note that beans are also dicots. Open the cotyledons carefully. Does the hypocotyl point toward the position occupied by the micropyle? Dissect out the plumule and cotyledon bearing it, together with the hypocotyl. Sketch. Note the absence of endosperm in these typical dicots.

Castor beans. Examine both faces, noting differences. The seed resembles an insect somewhat, which may have something to do with its distribution. *Do not place in the mouth*, as castor beans may be poisonous if swallowed. Note the line running down one side. This is termed the "raphe." The swellings at the pointed end are termed the "caruncle." The hilum is located where the raphe joins the caruncle. The micropyle is covered by the caruncle, which is an outgrowth around it. Carefully split two or three soaked specimens to determine the internal anatomy. The cotyledons in this case, although two in number, are flat and thin, thus being unable to contain much nourishment. The food is contained in the large amount of white endosperm, which is in two sections. The tiny plumule and hypocotyl will be found at the base of the leaflike cotyledons, just above the caruncle.

Squash seeds. Is the testa rough or smooth? Remove the testa carefully. There is an extremely thin layer just beneath the testa, known as the "tegmen." The thin greenish layer observed next is the endosperm. Upon dissection, the cotyledons will be observed to be much thinner than in the bean. The plumule is small, between the cotyledons. The cotyledons end in a little point; this is the hypocotyl. See if you can find these seed parts, and show them to your teacher.

Corn grains. These will serve as examples of monocot structure. Botanically, a grain such as corn, wheat, or rice, is not a seed, but a one-seeded fruit, which is technically termed an "achene." In the development of the fruit the seed and fruit coats become fused at maturity. The fruit or grain, however, functions as a seed in germination. Examine dry and soaked specimens. Note the hard outer wall. Study

prepared microscopic slides of corn (*Zea mays*) grains under the low power of the compound microscope. Note the large area of "endosperm." The single cotyledon is pointed, extending upward into the endosperm. Near the base of the cotyledon are the plumule (sometimes designated as "epicotyl") and the hypocotyl, with the "radicle" at its lower end. The plumule may sometimes be seen to consist of several little leaflets which will develop in germination as piercing blades.

In What Ways Are Seeds Important to Man?

Using all available sources of information, including your textbook, references in the laboratory and school library, personal interviews, and visits to places aiding botanical study with which you became familiar earlier in the school term, prepare a table indicating the various *economic uses* of seeds to man. Flour, rice, and hominy are examples of use for food; oils and medicines are supplied by many seeds. Indicate in your tabular summary the common name of each seed, what it supplies, in what way it is important to us, and where it grows. The science of *plant breeding* is dependent upon the carrying on of desired qualities of "inheritance" through seeds. Do you think that this is important to man?

How Are Seeds Dispersed?

Look up in the various references, and describe in your notes, examples of seed dispersal by the four common methods given: (1) wind, (2) water, (3) animals, (4) explosion. Can you bring to class and show the instructor an example of one or more of these types from outside the laboratory? Real specimens are better than pictures, but harder to obtain, of course. If enough types are brought into the laboratory, we shall prepare an exhibit together. Laboratory demonstration material is available for use in making a sketch of one type illustrating dispersal by each of the four means outlined above. Enter these in your notebook.

Germination and Growth

What Effect Has Depth of Planting upon Germination?

Obtain two long wide-mouthed bottles. Plant a number of soaked seeds in rings next to the glass in such a manner that the germination may be observed from without. Plant at different depths; the lowest ones at the bottom, the top ones barely covered. Use peas in one container, wheat in the other. Make comparative sketches illustrating your results.

Observe over a period of ten days. At what depth do you find by your recorded observations that each seed type germinates best? Conclusion?

How Much Effect Has Moisture upon Germination?

Prepare "germinators," covering the bottom of pans with soaked paper towels. Use sunflower seeds, if available, because they germinate quickly. Arrange four pans as follows:

No. 1. Dry seeds in a dry pan.
No. 2. Moist (soaked) seeds in a moist pan.
No. 3. Damp (soaked) seeds in a damp pan.
No. 4. Wet (soaked) seeds covered with water.

Number each pan and observe over a period of one week. Record your observations every other day. Results? Conclusion? (Sketch each germinator at the beginning and end of your experiment to illustrate the results obtained.)

How Much Effect Has Heat upon Germination?

Prepare four germinating pans for use. Place twenty soaked peas in a pan of water. Heat to 20 degrees centigrade; maintain at that temperature for ten minutes. Take out five seeds and place in germinator No. 1. Now raise the temperature of the water to 30 degrees centigrade; maintain for ten minutes. Take out five seeds and place in germinator No. 2. Raise to 85 degrees centigrade, maintain for ten minutes, and place in germinator No. 3. Heat to 100 degrees

centigrade (boiling), keep at this temperature for ten minutes, and place in germinator No. 4.

Observe the heat-treated seeds for a period of one week. What temperature seems to be the best suited for seed germination? What conclusion can you draw from your observation of this experiment?

What Effect Has Light upon Germination?

Place half-a-dozen soaked sunflower seeds on an uncovered germinating pan in a light place. Observe over a period of ten days.

Repeat, placing germinator in a dark place. Observations? Conclusions?

To Make a Comparative Study of the Time Required for Germination

Arrange in numbered germinators a few soaked seeds of various kinds: wheat, sunflower, corn, beans, castor beans, peas, squash.

Keep all types under similar conditions of moisture, temperature, light, etc.

Record the time required for each to sprout. Conclusions?

Do Germinating Seeds Exert a Force?

Fill a small thin-walled glass jar with soaked pea seeds. Place a perforated cap tightly over the mouth of the jar. Why perforate the cap? Sprinkle lightly with water for a few days to keep moist. Deposit in a warm place. Result? Conclusion?

Where Does Growth Take Place in the Young Root?

Stretch sewing thread between the points of laboratory forceps. Moisten the thread with waterproof India ink. Mark off the root of a very young seedling into sections at intervals of about 1/8 inch. Carefully lay the seedling thus marked in a moist germinator. Observe occasionally until the next laboratory period. Can you determine where growth takes

place? Make small sketches at the beginning and end of the experiment.

Repeat, using other types of seedling roots.

What conclusions can you draw from this comparative study?

FIG. 38. These embryonic scientists are investigating seedling growth in the elementary laboratory. (*Photograph by Shaw, courtesy of the Brooklyn Botanic Garden.*)

Where Does Growth Take Place in the Young Stem?

Prepare thread marker as in the previous experiment. Mark off portions of sunflower seedling stems as you did the roots in the preceding problem. Allow the seedlings to grow for several days, measuring the spaces between the India ink markings. What happens?

Repeat, using bean, corn, and pea seedling stems. Make small illustrative sketches at various stages of development. What conclusions can you draw from the results of this comparative study?

What is the Effect of Gravity upon Direction of Growth?

Plant a sturdy bean or nasturtium seedling about 4 inches long upside down in a flowerpot suspended by a string from a nail in the laboratory wall. Plant the seedling in such a way that the stem projects downward through the circular hole in the bottom of the flowerpot; the root extending upward through the sawdust or soil used. Water carefully throughout the experiment.

Observe the behavior of the stem during a two-week period. The living stem should reverse itself in order to respond negatively to gravity. When the stem has definitely reversed its growth, invert the flowerpot, observing stem reaction as before. After as long a period in this position as time permits, remove the plant from the flowerpot with extreme care. Has the root been affected by the successive reverses of growth direction? Make sketches of the stem and root upon concluding the experiment, in addition to sketches of the stem at several stages.

Response to Gravity

Simultaneously with the setting up of the apparatus for the preceding experiment, lay a rapidly growing potted plant on its side. Every four days reverse the potted plant so that it rests on the opposite side.

After an observation period of about three weeks, carefully remove the plant from its container. Examine the stem and root, noting direction changes. Describe and sketch results. Conclusion?

Do Young Rootlets Exert a Force in Growing?

Prepare a small glass dish by filling the bottom with mercury (obtainable in the laboratory) to a depth of about ½ inch. Pour about a ¼ inch of water over the mercury.

Select very young but healthy-appearing seedlings of various kinds for this experiment, as unfavorable environmental conditions are to be encountered. Pin these to the sides of a circular flat cork fitting within the glass container with

as little mechanical injury as possible to the seedlings. Adjust the cork and attached seedlings so that the little rootlet of each seedling is well under water, but clearly not touching the surface of the mercury covering the bottom. Now cover the dish with a small glass plate, in order to retain moisture within. Place in a warm spot and examine occasionally for one week.

Mercury is fourteen times as heavy as an equal volume of seedling primary root, but if conditions are favorable and the experiment successfully carried out, the root will attempt to force its way downward through this dense medium in positive response to gravitational force. Describe the results you obtained. What conclusions can you draw from this experiment?

Will Plants Grow Faster in the Light or in the Dark?

Place a group of seedlings in a well-lighted place. Place a duplicate group in a dark closet. See that general conditions of temperature, air, and water are uniform. Examine after a week or ten days. Which is the taller? Which do you think is the stronger and more healthy? Make a small sketch of each, illustrating results. What procedure would you recommend if your advice were asked on how to grow plants (*a*) quickly, (*b*) for strength and health?

ROOTS

How Are Roots Classified?

Bring root specimens into the laboratory. Classify each kind under its proper head. (Fibrous, fleshy tap, slender tap, aquatic, soil, etc.) Some roots will come under two or three heads. Describe your reasons for placing each root under the headings you have used. Where did you get the information necessary for this work?

The following will serve as suggestive types: Grass, beets, parsnips, turnips, carrots, sweet potato, ivy branch, wandering Jew, *Elodea*.

Describe, from your reference reading, the "adventitious" roots of the "banyan" tree of India.

Variation in the Form of Rootlets

Examine the various types of root growth obtained by the laboratory germination of corn, bean, wheat, castor bean, sunflower, and pea seeds. Sketch a single example of each to show arrangement and number of branch rootlets. Distinguish between "primary," "secondary," and "tertiary" rootlets. What do these terms mean? Where did you get your information?

To Show That Plant Roots Give off Acid

Moisten fresh pieces of blue litmus paper with distilled water. Place these pieces of damp litmus over and beneath some of the growing rootlets obtained for study in previous problems. Be careful that the paper bedding of the "germinators" used is damp, but not wet, as too much water will excessively dilute the acid so that it will not give a satisfactory test. Examine after forty-eight hours. Do you find evidence of acid being given off by the cells of the roots? *What relation has this problem to that demonstrating the effect of acid upon rock?*

Diffusion

Prepare three glass cylinders filled with water. Drop a crystal of *potassium permanganate* (purple) in one, a crystal of *copper sulfate* (blue) in another, and allow the cylinders to stand quietly while placing a crystal of *potassium dichromate* (orange) in the third cylinder. Let stand for some days and observe the slow movement of the colored substances through the water.

Conclusion: What causes fluids to mingle during the process of diffusion, since they are not stirred up in any way? How is this process of importance in plants and animals?

Osmosis

When two liquids or gases of different densities are separated by a semipermeable membrane, the two will tend to flow toward one another; the direction of greater flow being toward the area of lesser concentration *for each specific substance*. Solids, of course, do not "osmose." The greater the difference in osmotic concentration, the more rapid the process. Each of the various substances in solution osmose independently. The process will continue until a state of equilibrium is reached.

Obtain a "skin" from a sausage Cleanse it with great care so as to remove all meat, but do not puncture the membrane. Fasten this natural semipermeable membrane over the end of a glass "thistle tube." Fill the expanded end of the thistle tube with a solution of sugar and water. Now fasten the thistle tube to a "ring stand" in such a way that the sausage-skin "semipermeable membrane" is under water, contained in a large beaker or glass.

Observe the osmosis demonstration you have set up for a period of two days. What happens at first? What finally happens? See if you can find the reasons for what you have seen. What relation has "osmosis" to plant and animal cells in living bodies?

An Optional Plant Experiment Illustrating Osmosis

Obtain a large firm potato, a piece of glass tubing 10 or 12 inches long, a bored cork, and some salt. Carefully bore a hole about 2 inches deep into the potato, the size of the bored cork. Next, cut off the opposite end, away from the bored hole. Scrape around the cut surface a little.

Now fill the bored hole with salt solution and fit the glass tube into the hole by means of the bored cork. Be certain that the tube fits tightly, if necessary dropping a little melted paraffin around the bored cork and glass tube fitting. Now fasten the glass tube, with the potato at the bottom in a ring stand, with the scraped, cut bottom of the potato

immersed in a glass or beaker of water. Let the experiment stand for a school day, observing what takes place.

What Is the Nature of Absorbing "Root Hairs"?

Examine the little rootlets of the germinated seedlings which you grew during your experiments on seed germination. If these have been destroyed, fresh seedling rootlets may be grown in a germinating pan. Notice the "fuzz" which develops along the sides of these rootlets. Sunflower, corn, and squash show this well. These "fuzzy" structures are *root hairs*, tiny absorbing structures into which soil water and minerals in solution are absorbed by the process of "osmosis" which was studied earlier. Each root hair is in reality an extension of an epidermal (outer skin) cell. Water and dissolved substances osmose through the outer cell wall, diffuse throughout the "cytoplasm," and come in contact with the inner cell wall. This is penetrated by osmosis again; thus through alternate osmosis and diffusion, liquids are absorbed into the plant root. Make illustrative sketches to demonstrate your observations.

Root Adaptations for Absorption

What conditions are necessary for absorption? Discuss this process as related to aquatic (water) plants. Do these aquatic roots bear root hairs for this function? Describe absorption in the lower plant types known as "fungi."[1] Where is the absorbing zone in the root of a higher seed plant? What structures characterize this zone?

Root Pressure

What causes "bleeding" when plants are pruned at the wrong season? In order to observe this plant bleeding in the laboratory, cut off the stem of a geranium or other potted plant, fastening a short piece of rubber tubing to the cut

[1] The departmental science laboratory should have supplementary references of a type understandable and usable by the young investigator, for example, Parker, Bertha M., *Dependent Plants*, Row, Peterson & Company, Evanston, Ill., 1944.

base. Suspend a thin glass tube above, using a ring stand, and connect. A few drops of water should be placed over the cut end through the tube to prevent drying and sealing. Water the plant well and watch for two or three days. Explain the results obtained. Conclusion?

Attraction to Water as a Guiding Force

Try the following experiment to show that roots seek water, watching carefully throughout to prevent death through desiccation: Stretch a double layer of cheesecloth over the wide mouth of a water glass or beaker. Place a layer of paper toweling or cotton between. Cut small holes through this covering large enough to permit the penetration of rootlets. Place various types of seedlings on this covering so that their rootlets pass through. Wet the cotton thoroughly, but keep the glass beneath it dry. Observe the rootlets for forty-eight hours, keeping the cotton wet. Result? Now fill the glass with water until close to the rootlet tips. Allow the cotton to become dry. Observe for forty-eight hours. Conclusion?

What Are the Functions of Roots?

Is *water absorption* a function? What are the uses of water to a plant? Classify living plants upon the basis of their water requirements. What is a "water table"? In what forms is water contained in soil? *Absorption of inorganic salts* is another function. Give examples. Show how *transportation* and *anchorage* may be considered as functions. What is *stored* in roots? In what form? Give examples of plants which *propagate* themselves by their roots. List those which attach themselves by adventitious roots, climbing walls of buildings and other plants.

Stems

Field Study of Stem Types

Prepare a *survey list* of local plants as indicated below. (Use common names.) Describe locality where each is found.

Make a sketch illustrative of each type. What reference books did you use?

Two "annuals."
Two "biennials."
Five "perennials."
Five herbaceous stem plants.
Five woody stem plants.
Five erect stem plants.
Five climbing stem plants.
Two prostrate stem plants.
Two submerged stem plants.
One underground stem plant.

Field Study of Stem Modifications

Arrange as in the preceding problem, a survey list of local plants which in your opinion show modifications in stem structure as adaptations to environment. Make illustrative sketches. Describe occurrence and habit of each example. What reference books did you use to guide your field study?

Field Study of External Stem Structure

Study the "flora" about the school and vicinity as in previous investigations. What does the word "flora" mean?

List (by common name) the local plants which, from examination of their stem structure, you believe to be "monocots." Give the locality of each. Sketch a portion of the external stem structure of each example. Label nodes, internodes, lenticels, lateral buds, if present. Describe.

List (by common name) the local plants which you believe to be "dicots" from examination of their stem structure. Give locality of each. Sketch a portion of the external stem structure of each. Label. Describe.

List (by common name) the local plants which you believe to be "polycots" from examination of their general structure. Give locality of each. Sketch a portion of the external stem structure. Label. Describe.

What book references did you use as an aid in your field study?

Study of Buds and Branches

Obtain a few branches bearing buds. Examine and dissect when necessary. Distinguish the terminal buds, lateral buds, nodes, internodes, bud scars, lenticels. Draw. Label. Describe.

Make a longitudinal section of a growing stem tip of an herbaceous bud. Examine with lens and microscope. Can you distinguish the origin of axillary buds and leaves? Sketch. Against what dangers do buds afford protection? What is a dormant bud? What is an adventitious bud?

Describe examples of typical forms of branching you find about the school Designate whether excurrent, deliquescent, or mixed. What reference books have you used to aid your study?

What Are Methods of Grafting?

Using your class notes and available references as guides, describe in your permanent laboratory notebook the various types of grafting. Sketch those used most commonly today. Distinguish clearly between *stock* and *scion*. Upon what factors does the success of the graft depend? Can two plants of widely differing genera be successfully grafted? Can two of different but closely related species? Two of the same species? Discuss some of the results of this practice that you have observed.

Leaves

The General Structure of Leaves

Materials. Leaf specimens of various local types.

Make a sketch of each type. Label the blade, veins, petiole, and stipules Describe the external appearance and texture in each case. Odor? Taste? Comparative size? Venation? Margining? What things do all leaves have in common?

Field Study and Collection of Leaf Types

Study in the field the flora of the school and vicinity, observing variations in the external form of leaves. Observe

veining, lobing, marginal characters, and compounding. Collect samples of each type and take them to the laboratory, where they are to be pressed, organized, and the best examples mounted permanently in the laboratory notebook. Arrange in some system and take care that each is labeled correctly. In making the field collection, only rather small leaves should be taken, so that several different kinds may be mounted on one sheet of drawing paper.

What Does a Plant Leaf Look Like Inside?

It is important for us to find out about the internal structure of plant leaves, because they are important to man and all other animals. If there were no green plant leaves, there would be no green plants, for food is manufactured in the leaf plant factories.[1] If there were no green-leaved plants, there would be no "parasitic" or dependent plants, nor would there be any animals; for animals either eat plants, or eat animals which eat plants, or else they eat animals which eat animals which eat plants!

Gather a few leaves of various kinds that have been brought into your laboratory. Begonia or "wandering Jew" leaves are very good for this experiment. Strip the thin outer skin, known as the "epidermis," from the underside of one of these juicy leaves, and mount the bit of plant leaf epidermis on a glass microscope slide, using a little water to cover it. Place a thin "cover glass" on top and examine the leaf epidermis under the low power of the compound "monocular" microscope. Do you see any tiny openings? These are known as the "stomates," which have the function of admitting air into the leaf and letting water and oxygen out. A little carbon dioxide gas comes out through these stomates also, especially at night.

Notice the curved cells on each side of these tiny openings

[1] Among references which will be found adaptable to pupil use in this connection, see: Beauchamp, W. L., Williams, M. M., and Blough, G. O., *Discovering Our World*, Vol. 2, Basic Studies in Science Series, Scott, Foresman & Company, Chicago, pp. 209–219, 1947. Also Parker, B. M., *Plant Factories*, Row, Peterson & Company, Evanston, Ill., 1944.

in the leaf surface. These are called "guard cells," for they guard or regulate the size of the opening. The opening itself, of each stomate, is known to scientists as the "stoma." When the plant has plenty of water and "feels good," these guard cells arch out, enlarging each opening. When withered, the guard cells are flabby, and the opening is smaller. Watering plants thus helps them to breathe as well as hold up leaves and flowers. Make a sketch illustrating the structure of these stomates as they appear to you under the microscope.

Transverse sections, if cut sufficiently thin in the laboratory, will demonstrate internal structure, but best results will be obtained from an examination of commercially prepared cross sections of leaves, furnished by your instructor. Examine under the low power of the compound microscope. Identify the upper and lower epidermis. Under the upper layer of cells locate the "palisade" layer of cells, standing on end. What vital substance do these cells contain? Beneath the palisade layer of cells try to see some large cells, with spaces between the groups. This layer is known as the "spongy tissue" because of its peculiar open structure. Veins usually may be distinguished in the spongy tissue, being cut during the sectioning of the leaf. Some of these veins bring water to the leaf to be used in food manufacture, others carry away dissolved food substance to other parts of the plant body. Make a careful drawing of the internal anatomy, labeling the structures identified.

Is Starch Present in Leaves?

Use leaves of a green plant that has been in the sunlight for a day. Remove a leaf and plunge it into boiling water for one minute. Remove it from the hot water and boil in alcohol. Result? Give reasons for this procedure. Next add a drop or two of iodine solution to the bleached leaf. Allow to remain on the surface for a moment, then rinse off with tap water. Examine the leaf carefully under the demonstration binocular microscope in the laboratory. Do you see tiny dark-blue or black spots? What do you think makes them? Com-

pare this experiment with the one you did earlier, giving the general chemical tests for the presence of starch, protein, sugar, and fats. Explain the connection between the two experiments.

Repeat the experiment, using a leaf picked in the early morning hours before the sun has shone upon it. Do you get the same results as above? Account for the difference, if any.

What Effect Has Light upon Occurrence of Starch?

For this experiment growing plants may be used. Any plant on the high school grounds will be satisfactory. Exclude sunlight from portions of the exposed leaves by means of black paper or other covering. Allow to remain on the growing plant for two days, then remove and test for the presence of starch as in the preceding experiment. Sketch the covered leaf in position on the plant, and sketch to illustrate results following the laboratory test. In practice, nurserymen have found that photosynthesis may also be carried on in artificial light, which explains the winter "forcing" of florists' plants and blooms.

What Effect Has Suffocation upon Occurrence of Starch?

Use a *control* in this experiment (a leaf similarly exposed but not treated in any way). Cover both surfaces of a healthy leaf with a thick layer of white vaseline. What physiological effects will this have? Expose both control and coated leaves to direct sunlight for a day. Boil both leaves separately, and treat separately in testing for starch as in previous problems. What results do you get? Are you able to explain the results you observed?

How May We Demonstrate Transpiration?

What is "transpiration"? About how much water passes through a normal healthy plant during a summer day? Ask your teacher to carefully explain what makes water go up a tree. How is transpiration checked in hot arid climates? List some environmental factors influencing transpiration. In the laboratory, place a healthy potted plant under a large bell

jar. Cover the sides and top of the pot with melted paraffin, or transplant the plant to a large glass beaker, then coating the top only with wax. Why is this necessary? Place the bell jar and its contents in a sunny spot and observe after a few hours. Result?

Try the similar experiment of placing a long-stemmed leaf, such as Nasturtium, on a cardboard covering a glass of water, allowing the petiole to penetrate down into the liquid, while covering the exposed blade above with another glass, turned "upside down," and dry. Expose to the sun for a few hours. Result? Sketch the apparatus set up in each case. Conclusions?

Do Leaves Give Off Oxygen? (Photosynthesis)

Submerge a green water plant in a beaker nearly full of water. Invert over the plant a short-stemmed glass funnel. Cover the funnel stem with a glass test tube, filled with water and inverted in such a manner as to exclude air. To do this, fill the test tube to the very top with water, then *slide* a microscope glass slide or other small piece of glass over the top, doing this without making any "bubbles." Now turn the test tube upside down, holding the glass slide over the top as you do so, in order that the water will not fall out. Holding the slide in place firmly, place the mouth of the test tube under the water. Now, remove the glass slide cover and place the tube over the end of the short funnel stem, under water. Air pressure holds the water up in the tube.

Place the apparatus in direct sunlight. Examine after twenty-four and forty-eight hours. Do you notice any bubbles rising from the leaves of the plant? Where do they come from? What gas do you think makes them? Can you explain how it is formed? How would you prove by test what gas is formed? Sketch the apparatus. Conclusion?

Is Sunlight Necessary in Order That a Plant May Give Off Oxygen?

Repeat the previous experiment, keeping the apparatus in a dark place. Are many bubbles given off during the course

of the experiment? What is the final result? Give your reasons for the results obtained. Sketch as in the previous exercise, showing difference (if any) in result. Conclusion?

Is Carbon Dioxide Given Off from Green Leaves? (Respiration)

Show that CO_2 is a product of respiration by exhaling through a glass tube into a test tube containing pure limewater. What is limewater? Describe what happens.

Place a dish of clear limewater in a vessel containing many fresh green leaves and seal tightly. Observe for two or three days. Sketch the apparatus. The formation of a milky-colored precipitate, at least on the surface of the limewater, indicates the presence of carbon dioxide.

Results? Conclusion?

Do Leaves Respond to Light? (Phototropism)

Place an actively growing plant in such a way that the majority of its leaves are turned away from the light. Observe over a period of several days. Sketch to illustrate. Result? Conclusion?

Observation of Leaf Tropisms in the Field

Observe healthy growing plants on the school grounds, in parks, and in fields or woods nearby. Do you find any examples of "leaf mosaics" on the trees or shrubs? Explain from your reference reading what a "leaf mosaic" is. Try to locate examples of (1) "alternate," (2) "opposite," and (3) "whorl" leaf arrangement. Discuss the relative merits of each plan for *obtaining sunlight* on each leaf. Do you notice "rosettes" of leaves on plants growing close to the ground? In what way might this arrangement be of advantage to the plant in its struggle for existence? How might it be disadvantageous? What are "tendrils"? How do they function? Describe how tendrils are growing on plants which you find bearing them.

Flowers[1]

Study of a Flower Type with a Superior Ovary

Obtain specimens of a "trumpet" flower (*Bignonia campreolata*) for study. (*Any other local large flower of the type demonstrating this form may be used, with slight variation in the specific directions as detailed for dissection of the trumpet.*)

Describe the flower as to external appearance, noting color, shape, texture, etc. Sketch from a lateral external view. In the trumpet vine or morning glory type of flower, the petals are fused to form a funnel-tubed "corolla," the short fused sepals forming the "calyx." Place the fingers of one hand upon the bottom of the corolla tube, the other hand firmly grasping the petiole and calyx. With a twisting motion separate the corolla (which bears the stamens within it) from the calyx (from which the "pistil" extends upward) and lay this to one side.

With scalpel and scissors slit down one side of the flower petals, which in this particular kind of flower are fused into the corolla. Fold the petals back to observe the inner structure. Into how many parts is the corolla divided near the top? Note the attachment of the stamens within the corolla base. How many stamens are there? Describe the form of these plant organs.

Remove an entire anther and study under the dissecting binoculars. Sketch, showing attachment to the filament. Mount several pollen grains on a dry slide; study, describe, and draw under the low and high powers of the compound microscope. Sketch the pistil in detail to show the stigma form, indicating style and ovary in position. Dissect the ovary under the binoculars, using dissecting needles and small scalpel. How many compartments do you find?

An Autumn Flower Type with an Inferior Ovary

Obtain specimens of ***Fuchsia*** blossoms, (or other local inferior-ovaried form) and examine closely. Note that the

[1] For definitions of botanical terms, see *Teacher's Reference Terminology on Flowers.*

Fuchsia flower is "quadremous," being in fours or a multiple thereof. Note also that the sepals form part of the flower arrangement. How many sepals? How many petals? How many stamens? Is the relative position of the pistil and stamens such that self-fertilization is probable or improbable? What is the situation with regard to relative maturity of the pistil and stamens in your own flower specimen?

Sketch all the flower parts so far examined. Make a cross section of the inferior ovary and count the *locules* under the binocular microscope. How many are there? Are the ovules on a central *placenta*? Explain these terms. The small green seedlike structures at the base of the perianth (calyx and corolla) tube are nectar-cup growths.

An Early Spring Flower Type with an Inferior Ovary

Obtain specimens of *Freesia* for examination in the laboratory. This flower is a member of the Iris family, represented throughout the United States by such flowers as the *Iris* and *Gladiolus*. Describe the entire blossom as to general appearance, texture, and coloring. Sketch the flower as you see it from the outside, showing the position of the ovary with reference to the other flower parts. Notice the paperlike bract, or "spathe," at the bottom of the flower. (In the calla "lilly" the spathe is the most prominent flower part, being colored, spotted, or golden.) Remove this spathe with your forceps, observing that petals and sepals are united above the ovary into a "perianth" tube. Note that in the *Freesia* flower the "floral envelope" consists of sepals as well as petals: Can you distinguish definitely which lobes are sepals? How many are there of each? Remove a sepal and a petal. Sketch each. Can you find the three stamens? Compare with those of the trumpet flower. Where are they located? Remove one and sketch under the binoculars.

Mount pollen grains on a dry slide and study under the compound microscope. Sketch a few. How many pistils in this flower? How many stigmas? What do you think might be the function of the hairlike filament observed on the upper surface of each sepal? Dissect away the perianth.

With a sharp scalpel or razor blade cut transverse and longitudinal sections through successive flower ovaries. Mount your sections on slides and study under the dissecting binoculars, using dissecting needles as probes. Are you able to distinguish the three "locules" or compartments of the ovary? How many "carpels" (dividing walls) are present? Can you find the "placenta" or point of attachment for the ovules? This is a "central" or "axile" placenta. (In other flower species, ovules are attached to the carpel walls, in which case the placenta is said to be "parietal.") The small rounded cells are ovules, which later, if fertilized, will develop into seeds.

A Composite Flower

Obtain specimens of pot marigold (*Calendula*) for examination in the laboratory as a type "composite." Composites are not single flowers, but each is a colony of individuals, united together. The group is at the climax of its evolutionary development, containing more than twelve thousand species, or one-seventh of the entire flowering vegetation on our earth. The composite group is generalized, being fitted for survival of almost any climatic or soil variation.

Examine the upper surface of your specimen through a hand lens or beneath the dissecting binoculars. The plant organs which look like petals are grouped around the central button and are the "ray" flowers. The central button is composed of closely packed "disk" flowers. The entire floral arrangement is supported by a cluster of green bracts (which resemble the sepals of other flower groups). This group of scalelike green bracts comprises the "involucre." Which are the most numerous, the marginal ray or the central disk flowers? Where are the youngest disk flowers located? How can you tell? Sketch the general appearance of the flower before dissection.

Remove a ray flower from its base within a bract axil. Study under a lens. The small structure at the base of the ray is the pistil. Do you see any stamens? In a few composite

types (*Coreopsis*) the ray flowers bear neither stamens nor pistils Some bear no ray flowers whatever. The ray flowers, then, are not essential to seed development, hence they must serve to attract insects, aiding in the cross pollination of the disk flowers. Draw a ray flower under the binoculars.

Study a disk flower (using dissecting needles as probes) under the lens. Note that the flower is borne within an axil of a bract as is each ray flower. Open one of the flowers carefully, locating the tiny ovary enclosed in the lower calyx, the sepals being united. The petals, also, form a corolla tube. Remove the corolla tube and locate the stamens. How many are there? Are these also united? Find the pistil at the center. Trace it down to the ovary. Where is the style with reference to the anthers? The ovary, when it becomes mature, will form what is known as an "achene" or one-seeded fruit, bearing barbs, hooks, or tufts (cocklebur, dandelion) which will aid in later seed dispersal.

Study an inner immature disk flower. Notice that the stigma is enclosed within the surrounding well-developed anther tube. Comparison with older flowers will demonstrate that the style elongates after the anthers have shed their pollen cells and pushes the stigma outward in order that it may receive pollen. Of what advantage is this process to the plant? Discuss the relation of this process to the present-day climax association characterizing composites. Make sketches illustrating your observations in the laboratory.

TEACHER'S REFERENCE TERMINOLOGY ON FLOWERS[1]

Flower Parts

Each of the leaflike structures which protect the flower while it is in the "bud" stage is called a *sepal*. The sepals

[1] This section and that which follows as the *Teacher's Reference Terminology on Fruits* are appended here as aids in clarifying the relatively unfamiliar terms associated with botanical studies of these plant organs. The section is not intended for upper elementary or junior high school pupil study, but rather as reference material providing a basis for classroom explanation in answer to students' questions.

flatten out when the flower matures, becoming part of the flower structure as they support the *petals*. Sometimes the sepals are colored, or otherwise quite difficult to distinguish from the petals but their point of origin is always outside that of the petals. All the sepals collectively form the *calyx*. All the petals collectively form the *corolla*. The calyx and corolla together constitute the *perianth*.

The little hairlike structures situated within the perianth which terminate in small knobbed enlargements are called *stamens*. These are the male organs of reproduction in flowering plants. *Pollen* cells, produced on the stamens, functionally resemble sperm cells in the animal kingdom in that each contains a reproductive or generative nucleus, which contains plant "chromosomes" housing the "genes" bearing the inheritable characteristics of the plant producing the pollen. Each stamen consists of a *filament*, topped by a knobbed *anther*. The filament in each case holds up the anther, which often has two halves or lobes, bearing the pollen cells.

The central flower part is the *pistil*. Sometimes there are more than one. The pistil is the female organ of reproduction. It consists of an upper portion, the *stigma*, a neck or *style;* and a basal *ovary*. The stigma is covered with a sticky excretion (for catching pollen). The style is a hollow tube. The ovary contains little undeveloped seeds known as *ovules*. These correspond to unfertilized eggs in the animal kingdom. If the ovary is above the point of union of the rest of the flower parts, the ovary is said to be "superior." If the ovary is below the point of union of the rest of the flower parts, the ovary is termed "inferior."

When there is one stigma, one style, and an ovary of one wall (*carpel*) enclosing one cavity (*locule*), the pistil is said to be "simple." Compound pistils may be (1) several stigmas and styles uniting at the base into several carpels and locules, or (2) a single stigma and style spread out at the base to form several carpels and locules. The point of attachment of the unfertilized ovules to the parent ovary wall is termed the *placenta*. The same term is used in human embryology to

define the place where the human embryo contacts the body of the mother. There are commonly three types of botanical placentation: (1) If the ovules are centrally attached to a median axis, and there is but one locule, placentation is said to be "central." (2) If the ovules are attached to a central axis, but contained in several locules, placentation is "axile." (3) If the ovules are attached to the inner surface of the ovary wall, placentation is "parietal."

Sometimes we use the terms "essential" and "nonessential" in discussing flower parts. The former parts are absolutely necessary, the primary function of reproduction not being possible without them. Stamens and pistils are essential organs. The perianth (calyx and corolla), while helpful in attracting insects and hummingbirds and thus furthering cross pollination, is not actually necessary. Many types of flowers, as a matter of fact, have no perianth at all, depending upon wind pollination. Petals and sepals are thus listed as "nonessential." The upper portion of the stem which bears the flower stalk is known as the *receptacle*. The lower portion of the flower stalk is the *pedicel*. Some flowers, particularly composites, show a circle of overlapping modified leaves or "bracts" at the base of the pedicel. This is called an "involucre."

Hypogynous, Perigynous, and Epigynous Flowers

Hypogynous (superior-ovaried) flowers are characterized by the separate insertion of sepals, petals, and stamens below the ovary. *Perigynous* (also superior-ovaried) flowers demonstrate a cuplike upward spreading of the receptacle so that it partially envelops the ovary. Stamens, petals, and sepals arise from the receptacle cup, apparently, but not actually, above the ovary. *Epigynous* (inferior-ovaried) flowers have their ovaries clearly below the point of union of the rest of the flower parts.

Complete and Incomplete Flowers

Complete flowers show sepals, petals, stamens, and pistils, either separate or united. Both essential and nonessential

organs are represented. *Incomplete* flowers have one or more or these parts missing.

Choripetalous, Sympetalous, and Apetalous Flowers

Choripetalous flowers have petals more or less distinct or separate from one another, as in the poppy or mustard. *Sympetalous* flowers show a union of the petals, forming a corolla tube, as in the trumpet flower or morning glory. *Apetalous* flowers are without petals. Most of the wind-pollinated flowers, such as the pines, are of this type. Many species of buttercup are apetalous, the "petals" actually being sepals.

Perfect, Imperfect, and Sterile Flowers

Perfect flowers are monoecious or hermaphroditic; both male (staminate) and female (pistillate) organs being present in the same flower. Fuchsias, trumpet flowers, geraniums, and many other well-known flowers are "perfect" in this sense. *Imperfect* flowers are dioecious or single-sexed, being either staminate (male) or pistillate (female). Asparagus and willow are examples. *Sterile* flowers are without stamens and pistils, hence are not reproductive. These are comparatively rare, plants bearing such flowers necessarily propagating by other means (creeping rootstocks, artificial cuttings, etc.). *Hydrangea* flowers, common in semitropical American gardens, are sterile.

Composite Flowers

Composites, while appearing to be a single bloom, are in reality many flowers in one. This type of inflorescence is termed a "head." Usually there are two types of flowers represented in a composite bloom:

1. The *disk* flowers (forming the central portion) are each composed of a pistil, five stamens (anthers being united into an anther tube surrounding the pistil style), five petals, and a reduced calyx called a "pappus."
2. The *ray* flowers, surrounding the disk, consist of flattened

or tubular petals. Stamens, and often pistils also, are missing.

The leafy bracts under the head (often mistaken for "the" calyx of "the" flower) form the supporting "involucre."

Types of Inflorescence

A. Racemose inflorescence (flowering) shows a continuous development of the principal flower axis. There are several variations of this general type.

Racemes are commonly noted. Alternating lateral flowers are borne on short stalks. Type genera: *Capsella* (shepherd's-purse), *Brassica* (mustard), *Malcolmia* (stock), *Convallaria* (lily of the valley), *Hyacinthus* (hyacinth).

Spikes show alternating lateral flowers without stalks, borne on a central axis. Type genera: *Lolium* (rye), *Hordeum* (barley), *Triticum* (wheat), *Plantago* (plantain).

Catkins are closely packed (sessile) staminate or pistillate flowers, arranged in spike fashion. Scaly bracts are usually present. Often the entire spike droops and comes off after flowering. Type genera: *Salix* (willow), *Populus* (popular), *Betula* (birch), *Quercus* (oak).

Spadix flowers each show a monoecious fleshy spike, enveloped in a modified leaf structure called a "spathe." Type genera: *Washingtonia* (palm), *Richardia* (calla lily), *Arisaema* (Jack-in-the-pulpit).

Umbels show flowers with stalks of approximately the same length, all originating at a central place. Type genera: *Pastinaca* (parsnip), *Apium* (celery), *Daucus* (carrot), *Brodiaea* (blue dick), *Cercis* (Judas tree).

Corymbs show alternating flowers with stalks of unequal length, forming a flat-topped raceme. Type genera: *Pyrus* (pear), *Crataegus* (hawthorn), *Prunus* (cherry).

Panicles are freely branched racemes, spikes, or corymbs, forming compound flowers. Type genera: *Yucca* (Spanish bayonet), *Poa* (bluegrass), *Avena* (oat), *Agrostis* (bent grass), *Hydrangea*, *Ceanothus*.

Heads are flattened terminal flowers, often composites.

Type genera: *Trifolium* (clover), *Helenium* (sneezeweed), *Coreopsis* (tickseed), *Tagetes* (African and French marigolds), *Helianthus* (sunflower).

B. Cymose inflorescence: The main flower axis is terminal, while the lateral development is continuous. Type genera: *Tulipa* (tulip), *Phlox* (many species), *Trillium* (wake-robin or trillium lily).

Fruits

Botanically, a fruit need not be edible. It is the mature or ripened ovary, its contents, together with such incorporated flower parts as may be included with it. The function of fruits is to protect the seeds, aiding in their dispersal. There are two principal types, fleshy fruits and dry fruits.

A. Fleshy Fruits

Pome: Procure specimens of apples for study in the laboratory. These fruits show the development of the cup-shaped flower receptacle into an envelope containing the several-seeded ovary "core." (Pears are also "pome" fleshy fruits and may be studied in this connection simultaneously at the option of the student.) Examine the skin with a hand lens. Do you see tiny breathing pores (lenticels)? Examine the ends of the fruit. On the end opposite the stem, several small scales are present. These are the remains of the apple-blossom sepals. How many do you find? Distinguish the stamens. Can you locate the pistil styles? How many of each? Sketch this end of the apple under the binoculars.

Next cut a cross section through the middle of an apple and a longitudinal section through another. Compare the two sections in your study. The thin carpel walls may be seen enclosing the ovules (now seeds). The portion of the fruit surrounding the seeds is termed the "pericarp." In the cross section the outer boundary of the pericarp is indicated by a more or less circular ring, or scalloped line. The edible portion between this thin line and the skin is not a part of the ovary, or even a flower part, but the thickened, fleshy

flower foundation which in our flower study we have termed the "receptacle"

Drupe. Obtain specimens of olives, fleshy fruits. The ovary wall forms the edible portion. The inside layer of the ovary wall forms the hard portion (commonly called the olive seed) which surrounds the true seed. Sketch the fruit in vertical section. Plums, peaches, and cherries are fruits of this type.

Berry: Botanically, a "berry" is a special type of fleshy fruit. The tomato is a good example: Dates, grapes, persimmons, currants, and oranges are berries!

Pepo: Squash, pumpkins, and cucumbers are of this type. What distinguishes a pepo from other fleshy fruits?

B. Dry Fruits

These are of great economic importance, furnishing a large portion of our food as cereals. Also the greater part of our troublesome weeds are scattered by fruits of this class into crop fields.

Nuts feature a hard covering, containing usually a large single seed filling the interior. The hard covering is the pericarp. Draw a walnut, external view, and in longitudinal section.

The student is urged to acquaint himself, through available library and laboratory references, with other types of fruits. Among these may be mentioned dehiscent, legume, and accessory fruit forms. Ask your teacher to explain "aggregate" and "multiple" fruits to the class. Most of the fruits we commonly call "berries" are in these groups, according to the definitions agreed upon by plant students.

After your reference and laboratory studies, see if you can classify the following fruits:

Peach	Pineapple
Cherry	Strawberry
Bean	Blackberry
Lemon	Watermelon
Fig	Avocado
Rice	Banana

Teacher's Reference Terminology on Fruits

Fruits are mature or ripened ovaries, their contents, and all closely adhering flower parts, if any. Squashes, cucumbers and tomatoes are thus "fruits" in the botanical sense, although commonly called "vegetables." The distinction between fruits and vegetables is confusing and in need of clear definition. *Vegetables* may be defined as "any edible portions of plants which are not fruits." Cauliflowers (flowers), artichokes (buds), celery and rhubarb (leaf petioles), parsnips, beets, and carrots (roots) are thus vegetables, because they have not developed directly from an ovary.

A. Simple fruits (developed from a single ovary).

1. *Fleshy* (succulent ovary wall or "pericarp").

Pome: All "false" fruits, being formed of additional flower parts. An edible fleshy receptacle, the inner pericarp forming a "core."

Genera: *Pyrus* (apple, pear), *Cydonia* (quince).

Drupe or *stone:* One-seeded fleshy fruit. The three regions of the pericarp are distinct. The outer "exocarp" forms the skin, the middle layer, "mesocarp," forms the fleshy portion, while the inner layer, "endocarp," forms the hard pit.

Genera: *Prunus* (plum, peach, apricot, cherry, almond), *Olea* (olive).

Berry: The entire ovary becomes fleshy and usually edible. Often outer coverings, developed from the flower receptacles, are present. The seeds are embedded in the fleshy ovary wall. What most people refer to as "berries" are botanically classed as aggregate fruits. Grapes and tomatoes are true berries. Cucumbers and squashes are berries of the type known as "pepos" or gourds. An orange is a true berry, the rind being formed from the pericarp. The orange sections are locules. Bananas (false fruits) are also berries. The peel is developed from the flower receptacle.

Genera: *Citrus* (lemon, orange), *Lycopersicon* (tomato), *Cucurbita* (squash), *Phoenix* (date), *Vitis* (grape), *Musa*, (banana) *Cucumis* (cucumber), *Ribes* (gooseberry).

2. *Dry* (desiccated or leathery pericarp at maturity).

a. *Dehiscent* (pod splits open at maturity along a definite line or mark).

Legumes are dry fruits containing but one locule and which split along two lines.

Genera: *Pisum* (pea), *Phaseolus* (bean), *Medicago* (alfalfa).

Follicles are dry fruits containing one locule which split along one line only.

Genera: *Asclepias* (milkweed), *Paeonia* (peony), *Delphinium* (larkspur).

Capsules have two or more locules, the carpels of which do not separate. The mature fruit splits into as many parts as there are locules.

Genera: *Eschscholtzia* (California poppy), *Iris* (iris), *Azalea* (azalea).

Siliques have two carpels only, which separate at dehiscence.

Genera: *Brassica* (mustard), *Roripa* (water cress), *Raphanus* (radish).

b. *Indehiscent* (the fruit does not split open at maturity. No definite line visible. Thin seed coat. Usually one-seeded.)

Grain or *caryopsis* dry fruits are one-seeded, the seed coats and the fruit walls being fused together at all points so that the seed cannot be squeezed out of the fruit. The monocot grasses have typical caryopsis fruits.

Genera: *Triticum* (wheat), *Zea* (corn), *Oryza* (rice).

Achenes are one-seeded, but attached to the thin ovary wall at one point only.

Genera: *Ranunculus* (buttercup), *Bellis* (daisy), *Fagopyrum* (buckwheat), *Aster* (aster), *Helianthus* (sunflower), *Taraxacum* (dandelion).

Nuts have thick, hard pericarps, sometimes with outer enveloping involucre husks also. Botanical terminology clashes with the popular conception of "nuts" as is the case with berries. Nuts, as the term is usually applied, may be fruits or seeds. Peanuts, Brazil nuts, and cashew nuts are not true dry fruits, but hard-coated seeds.

Genera: *Quercus* (acorn), *Juglans* (walnut), *Carya* (hickory, pecan).

Key or *samara* fruits are one- or two-seeded. The pericarps are modified to form wings.

Genera: *Ulmus* (elm), *Acer* (maple), *Fraxinus* (ash).

Schizocarps are scissorlike in form, the two carpels separating at maturity, enclosing the seeds.

Genera: *Pastinaca* (parsnip), *Daucus* (carrot), *Apium* (celery), *Petroselinum* (parsley).

B. *Aggregate* fruits (each the outgrowth of a single flower with several pistils). Little drupes or achenes massed upon a common receptacle.

Genera: *Rubus* (blackberry, raspberry), *Fragaria* (strawberry).

C. *Multiple* fruits (the outgrowth of many separate, closely adjacent flowers).

Genera: *Ananasa* (pineapple), *Ficus* (fig), *Morus* (mulberry).

PART II

RESOURCE AIDS

AUDIO-VISUAL SOURCES OF SUPPLY

SOURCES OF 16-MM. MOTION PICTURES[1]

The majority of the sources listed below are industrial or governmental organizations which offer prints of films "on loan" to schools and other community organizations as a service in connection with their public relations programs. In addition to these sources, most *state universities* maintain extensive motion-picture exchange facilities, and information pertaining to their services may be obtained through correspondence.

Aluminum Company of America, Motion Picture Department, Gulf Building, Pittsburgh 19.
American Can Company, Motion Picture Division, 230 Park Ave., New York 17.
American Cancer Society, 47 Beaver St., New York 4.
American Dental Association, 212 East Superior St., Chicago 11.
American Forest Products Industries, 1319 Eighteenth St., Washington 6, D.C.
American Humane Association, 135 Washington Ave., Albany 6.
American Institute of Baking, 10 Rockefeller Plaza, New York 20.
American Museum of Natural History, 77th St. and Central Park West, New York 24.
American Nature Association, 1214 Sixteenth St., N.W., Washington 6, D.C.
American Red Cross, 19 East 47th St., New York 20.
American Viscose Corporation, 350 Fifth Ave., New York 17.

[1] For a more complete listing see *The Blue Book of 16-mm. Films* (issued annually; more than seven thousand films listed), Educational Screen, Inc., 64 East Lake St., Chicago 1. See also Mallinson, George G., *The Use of Films in Elementary Science*, Faculty Contributions, Series II, No. 2, Western Michigan College of Education, Graduate Division, Kalamazoo, June, 1950.

Australian Information Bureau, 610 Fifth Ave., New York 20.

Automobile Manufacturers Association, Transportation Bldg., Washington, D.C.

Baltimore and Ohio Railroad, Director of Public Relations, Baltimore.

Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N. Y.

Bell and Howell Company, 7191 McCormick Rd., Chicago 45.

Bell Telephone Company, Philadelphia.

Better Homes and Gardens, Des Moines, Iowa.

Better Vision Institute, 630 Fifth Ave., New York 20.

Boy Scouts of America, Public Relations Service, 2 Park Ave., New York 16.

Bray Pictures Corporation, Educational Department, 729 Seventh Ave., New York 19.

British Information Services, 30 Rockefeller Plaza, New York 20.

Burton Holmes Films, Inc., 7510 North Ashland Ave., Chicago.

Castle Films, 1445 Park Ave., New York 29.

Celanese Corporation, 180 Madison Ave., New York 16.

Chinese News Service, 30 Rockefeller Plaza, New York 20.

Commonwealth Pictures Corporation, 729 Seventh Ave., New York.

Coronet Instructional Films, Inc., 919 North Michigan Ave., Chicago.

Denoyer-Geppert Company, (Atlas Educational Films), 5235 Ravenswood Ave., Chicago 40.

DeVry Corporation, 1111 Armitage Ave., Chicago 14.

DuPont de Nemours and Company, Motion Pictures Department, Tenth and Market Sts., Wilmington 98, Del.

DuPont Rayon Division, Empire State Bldg., New York 16.

Eastman Kodak Company, 343 State St., Rochester 4, N. Y.

Edited Pictures System, Inc., 165 West 46th St., New York 19.

Encyclopaedia Britannica Films, 207 South Green St., Chicago.

Films Incorporated, 330 West 42d St., New York.

Ford Motor Company, Department of Photography, Dearborn, Mich.

General Electric Company, Visual Instruction Section, 1 River Rd., Schenectady 5, N. Y.

General Motors Corporation, Public Relations Department, 1775 Broadway, New York 19.

Girl Scouts, 155 East 44th St., New York 17.

Good Housekeeping, 959 Eighth Ave., New York.
Goodyear Tire and Rubber Company, Motion Picture Department, Akron 16, Ohio.
Ideal Pictures Corporation, 30 East 8th St., Chicago.
International Film Bureau, Inc., 6 North Michigan Ave., Chicago 2.
International Harvester Company, 180 North Michigan Ave., Chicago.
Jam Handy Picture Service, Incorporated, 2900 East Grand Blvd., Detroit 11.
Johnson & Johnson, New Brunswick, N. J.
Metropolitan Life Insurance Company, 1 Madison Ave., New York 10.
Metropolitan Museum of Art, Fifth Ave. at 82d St., New York.
National Association of Audubon Societies, 1000 Fifth Ave., New York 28.
National Dairy Council, 111 North Canal St., Chicago.
National Safety Council, 20 North Wacker Dr., Chicago 6.
National Tuberculosis Association, 1790 Broadway, New York 19.
New York Central Railroad System, 466 Lexington Ave., New York 17.
Nu-Arts Films, Incorporated, 145 West 45th St., New York.
Office of Inter-American Affairs, 444 Madison Ave., New York 22.
Owens-Illinois Glass Company, Toledo 1, Ohio.
Pan-American Union, Washington, D.C.
Pittsburgh Plate Glass Company, 632 Duquesne Way, Pittsburgh 22.
Plomb Tool Company, Box 3519, Terminal Annex, Los Angeles 54.
Pullman Company, Advertising Department, 79 East Adams St., Chicago.
RCA Manufacturing Company, Incorporated, Educational Department, Camden, N. J.
Santa Fe Railway, Advertising Department, 80 East Jackson Blvd., Chicago 4.
Science Publications (Lists of good films in science area requested), 201 North School St., Normal, Ill.
Scientific Film Company, 6804 Windsor Ave., Berwyn 1, Ill.
Shell Oil Company, 50 West 50th St., New York 20.
Spalding and Brothers, 19 Beekman St., New York.
Sperry Gyroscope, Motion Picture Department, Manhattan Bridge Plaza, Brooklyn, N. Y.

Sun Oil Company, 1608 Walnut St., Philadelphia.
Swift and Company, Union Stock Yards, Chicago.
Teaching Films Custodians, 25 West 43d St., New York.
Tennessee Valley Authority, Information Office, Knoxville, Tenn.
Texas Company, 135 East 42d St., New York 17.
Transcontinental and Western Air, Incorporated, 80 East 42d St., New York 17.
United Air Lines. Use closest address; see Booklets, Pamphlets, Pictures, and Posters.
United Fruit Company, Educational Department, Pier 3, North River, New York.
United Nations Information Office, 610 Fifth Ave., New York 20.
United States Rubber Company, 1230 Avenue of the Americas, New York 20.
U.S. Coast Guard, 42 Broadway, New York 4.
U.S. Department of Agriculture, Motion Picture Service, Washington 25, D.C.
U.S. Department of the Interior Bureau of Mines, Pittsburgh.
U.S. Department of Labor, Children's Bureau, Washington 25, D.C.
U.S. Marine Corps, Photographic Section, Marine Corps Schools, Quantico, Va.
U.S. Maritime Commission, Washington 25, D.C.
U.S. Navy Recruiting Service, 641 Washington St., New York.
U.S. Office of Education, Federal Security Agency, Washington 25, D.C.
U.S. Public Health Service, Washington 14, D.C.
U.S. Weather Bureau, U.S. Department of Commerce, Washington 25, D.C.
United World Films, Inc., 1445 Park Ave., New York 29.
Western Electric Company, 195 Broadway, New York.
Western Pine Association, Yeon Bldg., Portland 4, Ore.
Westinghouse Electric and Manufacturing Company, East Pittsburgh.
Wild Flower Preservation Society, 3470 Oliver St., Washington, D.C.
Willard Storage Battery Company, 246–286 East 131st St., Cleveland 1.
World Pictures Corporation, 729 Seventh St., New York.
Yale University Press Film Service, 386 Fourth Ave., New York.
YMCA Motion Picture Bureau, 347 Madison Ave., New York 17.
Young America Films, Inc., 18 East 41st St., New York 17.

Maps, Charts, and Globes

Chicago Apparatus Company, 1735 North Ashland Ave., Chicago.
Denoyer-Geppert Company, 5235 Ravenswood Ave., Chicago 40.
General Biological Supply House, 761 East 69th Pl., Chicago 37.
National Geographic Society, Sixteenth and M Sts., N.W., Washington 6, D.C.

Opaque Projectors

American Optical Company, Scientific Instrument Division, Buffalo 15, N. Y.
Ampro Corporation, 2839 North Western Ave., Chicago 18.
Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N. Y.
Charles Beseler Company, 131 East 23d St., New York.
Revere Camera Company, Chicago 16.

Stereographs and Stereoscopes

Keystone View Company, Meadville, Pa.

3¼- by 4-inch Glass Slides

Chicago Apparatus Company, 1735 North Ashland Ave., Chicago.
Coronet Instructional Films, Incorporated, 919 North Michigan Ave., Chicago.
Denoyer-Geppert Company, 5235 Ravenswood Ave., Chicago 40.
Eastman Educational Slides Company, Iowa City, Iowa.
General Biological Supply House, 761 East 69th Pl., Chicago 37.
Keystone View Company, Meadville, Pa.
National Audubon Society, 1000 Fifth Ave., New York 28.
National Geographic Society, Sixteenth and M Sts., N.W., Washington 6, D.C.

2- by 2-inch Slides

American Council on Education, 744 Jackson Pl., N.W., Washington, D.C.
California Biological Service, 1612 West Glenoaks Blvd., Glendale, Calif.
Chicago Apparatus Company, 1735 North Ashland Ave., Chicago.

Coronet Instructional Films, Incorporated, 919 North Michigan Ave , Chicago.
Denoyer-Geppert Company, 5235 Ravenswood Ave., Chicago 40.
General Biological Supply House, 761 East 69th Pl., Chicago 37.
Society for Visual Education, Incorporated, 100 East Ohio St., Chicago 11.

Slide-making Materials

Eastman Kodak Company, 343 State St., Rochester 4, N. Y.
Keystone View Company, Meadville, Pa.
Radio-Mat Slide Company, 1819 Broadway, New York.
Society for Visual Education, Incorporated, 100 East Ohio St., Chicago 11.

Tripods and Accessories

Eastman Kodak Company, 343 State St., Rochester 4, N. Y.
Neumade Products Corporation, 427 West 42d St., New York.

16-mm. Motion-picture Cameras

Bell and Howell Company, 7191 McCormick Rd., Chicago 45.
DeVry Corporation, 1111 Armitage Ave., Chicago 14.
Eastman Kodak Company, 343 State St., Rochester 4, N. Y.
Mitchell Camera Company, 665 North Robertson Blvd., West Hollywood, Calif.

Projection Screens

Da-Lite Screen Company, 2723 North Pulaski Rd., Chicago.
National Theatre Supply Company, 90 Gold St., New York.
Radiant Manufacturing Company, 1144 West Superior St., Chicago.

Film Splicing, Rewinding, and Editing Equipment

Craig Movie Supply Company, 1053 South Olive St., Los Angeles.
Griswold Machine Works, Port Jefferson, N. Y.
Neumade Products Corporation, 427 West 42d St., New York.

Microphones

Astatic Laboratories, Incorporated, Youngstown, Ohio.
Brush Development Company, Cleveland.

Radio Corporation of America. RCA-Victor Division, Camden, N.J.

Phonographs

Magnavox Company, Incorporated, Fort Wayne, Ind.
Radio Corporation of America, RCA-Victor Division, Camden, N.J.

Radio and Television Receivers

Farnsworth Radio and Television Company, Fort Wayne, Ind.
Magnavox Company, Incorporated, Fort Wayne, Ind.
Motorola, Inc., 4543 Augusta Blvd., Chicago 51.
Philco Radio and Television Corporation, Philadelphia.
Radio Corporation of America, RCA-Victor Division, Camden, N.J.
Radio Manufacturers Association, 1317 F St., N.W., Washington 4, D.C.
Zenith Radio Corporation, Chicago 39.

School Radio Sound Systems

Magnavox Company, Incorporated, Fort Wayne, Ind.
Radio Corporation of America, RCA-Victor Division, Camden, N. J.

Sound Amplifying Equipment

Magnavox Company, Incorporated, Fort Wayne, Ind.
Radio Corporation of America, RCA-Victor Division, Camden, N.J.
Stromberg-Carlson Manufacturing Company, 100 Carlson Rd., Rochester, N.Y.

3¼- by 4-inch Slide Projectors

American Optical Company, Scientific Instrument Division, Buffalo 15, N.Y.
Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N.Y.
Charles Beseler Company, 131 East 23d St., New York.
Keystone View Company, Meadville, Pa.

2- by 2-inch Slide Projectors

American Optical Company, Scientific Instrument Division, Buffalo 15, N.Y.

Ampro Corporation, 2839 North Western Ave., Chicago.

Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N.Y.

Bell and Howell Company, 7191 McCormick Rd., Chicago 45.

Eastman Kodak Company, 343 State St., Rochester 4, N.Y.

Society for Visual Education, Incorporated, 100 East Ohio St., Chicago 11.

Filmstrips

American Council on Education, 744 Jackson Pl., N.W., Washington, D.C.

Coronet Instructional Films, Incorporated, 919 North Michigan Ave., Chicago.

Eye Gate House, 330 W. 42d St., New York 18.

Jam Handy Organization, 2900 East Grand Blvd., Detroit 11.

Long Filmslide Service, 944 Regal Rd., Berkeley, Calif.

Metropolitan Life Insurance Company, 1 Madison Ave., New York 10.

Row, Peterson and Company, 1911 Ridge Ave., Evanston, Ill.

Visual Sciences, 599 N St., Suffern, N.Y.

Filmstrip Projectors

American Optical Company, Instrument Division, Buffalo, N.Y.

Ampro Corporation, 2839 North Western Ave., Chicago 18.

Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N.Y.

Golde Manufacturing Company, 1220-C West Madison St., Chicago 7.

Society for Visual Education, Incorporated, 100 East Ohio St., Chicago 11.

16-mm. Film Containers and Cabinets

Bell and Howell Company, 7191 McCormick Rd., Chicago 45.

Craig Movie Supply Company, 1053 South Olive St., Los Angeles.

Neumade Products Corporation, 427 West 42d St., New York.

Film Cement

Eastman Kodak Company, 343 State St., Rochester 4, N.Y.
National Theatre Supply Company, 90 Gold St., New York.
Neumade Products Corporation, 427 West 42d St., New York.

Film-cleaning Machines

Bell and Howell Company, 7191 McCormick Rd., Chicago 45.
National Theatre Supply Company, 90 Gold St., New York.
Neumade Products Corporation, 427 West 42d St., New York.

Projection Lamps

Mazda Division, General Electric Company, 1 River Rd., Schenectady 5, N.Y.
National Theatre Supply Company, 90 Gold St., New York.
Westinghouse Electric and Manufacturing Company, 306 Fourth Ave., Pittsburgh 30.

Spot and Flood Lights

Brenkert Light Projector Company, 7348 St. Aubin Ave., Detroit.
Kleigl Brothers, 321 West 50th St., New York.
National Theatre Supply Company, 90 Gold St., New York.

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BOOKLETS, PAMPHLETS, PICTURES, AND POSTERS: SOURCES AND ANNOTATIONS

Address	*Annotation*
Air Age Education Research 100 Park Ave., New York 17.	"The Airplane and How It Flies," "Opportunities for Youth in Air Transportation," and other teaching materials free on request.
Albers Milling Company, 5045 Wilshire Blvd., Los Angeles 36.	"The Cereal Story" and other pamphlets available free to teachers.
All American Aviation, Inc., 210 Greenhill Ave., Wilmington 99, Del.	Illustrated teaching materials on aviation service, free to teachers
Aluminum Company of America, Pittsburgh 19.	"Aluminum—Its Story," "An Outline of Aluminum," and other booklets, pictures, and charts free to teachers.
American Airlines, Inc., Public Relations Department, 100 East 42d St., New York 17.	"Air-age Education," an air-world map, and other teaching aids in air education free upon request.
American Audubon Society, 1000 Fifth Ave., New York 28.	Natural science educational pamphlets and bulletins, especially on bird life. A detailed list of titles on request.

American Can Company, Home Economics Department, 230 Park Ave., New York 17.	"The Study of Salmon," "The Story of Coffee," and other booklets about foods and nutrition, free to teachers on request.
American Cancer Society, 47 Beaver St., New York 4.	"Teaching about Cancer," "Youth Looks at Cancer," and many other authoritative pamphlets and booklets for use in public schools.
American Education Press, Inc., 400 South Front St., Columbus 15, Ohio.	"The Railroad Story," with a *Teacher's Manual*, and other pamphlets on transportation.
American Forest Products Industries, 1319 Eighteenth St., N.W., Washington 6, D.C.	"America's Forests," "Trees for Tomorrow," and other booklets. Also sets of elementary class-room posters, wall maps, and charts.
American Forestry Association, 919 17th St., N.W., Washington 6, D.C.	Charts and pamphlets on forest and conservation education free to elementary science teachers.
American Humane Education Society, 180 Longwood Ave., Boston 15.	"Care of the Dog," "Care of the Cat," "Ways of Kindness," and other pamphlets.
American Iron and Steel Institute, 350 Fifth Ave., New York 1.	"Steel from Mine to You," "The Picture Story of Steel," and other educational aids.
American Medical Association, 535 North Dearborn St., Chicago 10.	Authoritative *Health Publications*, free to science educators.

American Museum of Natural History, Central Park West at 79th St., New York 24.	"Man and Nature," a catalogue of popular scientific publications, of the museum sent free to teachers.
American Nature Association, 1214 Sixteenth St., N.W., Washington 6, D.C.	Teaching reproductions from *Nature* Magazine. List on request.
American Optical Company, Public Relations Department, Scientific Instrument Division, Buffalo 15, N.Y.	Booklets and charts of educational value free to teachers.
American Paper and Pulp Association, 122 East 42d St., New York 17.	"The Paper Industry" and other informative pamphlet materials.
American Petroleum Institute, 50 West 50th St., New York.	Pamphlets on products derived from crude petroleum, free.
American Public Health Association, 1790 Broadway, New York 19.	Bibliography on Health and allied subjects available to teachers.
American Seating Company, 9th St. and Broadway, Grand Rapids 2, Mich.	"The Coordinated Classroom" pamphlet, "Posture and Health" informative, charts free to teachers, also information on laboratory equipment and primary materials.
American Telephone and Telegraph Company, Educational Aids Division, 195 Broadway, New York 7.	"The Magic of Communication," "Miracle Men of the Telephone," and other booklets free to science educators.

American Tree Association, 1212 Sixteenth St., N.W., Washington, D.C.	Charts and pamphlets on trees and their conservation.
American Wool Council, Inc., 1450 Broadway, New York 18.	"A Capsule Course on Wool" and other educational pamphlets and materials.
Appalachian Hardwood Manufacturers, Inc., 414 Walnut St., Cincinnati 2.	"Appalachian Hardwoods, America's Finest," illustrated pamphlet free to elementary teachers.
Armour and Company, Public Relations Department, Chicago 9.	School charts on meat products free to teachers.
Armstrong Cork Company, 5011 Madison St., Lancaster, Pa.	"The Story of Cork," "The Story of Linoleum," and other materials.
Art Education, Inc., 6 East 34th St., New York.	Hundreds of pictures useful in science education. Write for catalogue.
Associated Wool Industries, 386 Fourth Ave., New York.	Informative teacher and pupil materials on wool.
Association of American Railroads, Transportation Building, Washington 6, D.C.	"The Iron Horse," "Science Rides the Rails," "Railroads at Work," and other illustrated bulletins. Lists of publications for children.
Atchison, Topeka and Santa Fe Railway Company, Public Relations Department, 80 East Jackson Blvd., Chicago 4.	Pictures and booklets on rail transportation free to teachers.

Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N.Y.	"The Educational Focus" and other bulletins, wall charts, and pamphlets for science education.
Better Vision Institute, 3157 International Building, Rockefeller Center, New York.	Booklets and pamphlets on better vision, light refraction, and optics. Limited quantities free on request.
Bituminous Coal Institute, Educational Department, Southern Bldg., Washington 5, D.C.	"Old King Coal Calls a New Tune" and other booklets. Also a coal exhibition kit. Materials free to teachers.
The Borden Company, 350 Madison Ave., New York 17.	Color photographs, "Daisies Will Tell," "Digest of Irradiated Milk Facts," and other materials.
Botany Worsted Mills, Passaic, N.J.	"Story of Wool Plaids," "How to Judge Woolens," "Facts on Wool," and other booklets.
Bristol-Myers Company, Department ST-25, 45 Rockefeller Plaza, New York 20.	Teaching aids on physical fitness, dental health, and personal grooming.
Brooklyn Botanic Garden, Elementary Education Department, 1000 Washington Ave., Brooklyn, N.Y.	Children at Work series: "Children Come Visiting," "Our Boys and Girls Club," "Our Pattern," "The Children's Garden," "The Children's Greenhouse."
Bureau of Agricultural Chemistry and Engineering, Department of Agriculture, Washington 25, D.C.	"Farm Products and By-products for Industrial Use."

Bureau of Reclamation, Department of the Interior, Washington 25, D.C.	A series of illustrated booklets on government projects in reclamation.
California Fruit Growers' Exchange, Educational Division, P. O. Box 5030, Metropolitan Station, Los Angeles.	"The Story of Oranges and Lemons," Sunkist Food Bulletins, and other health-teaching aids free to teachers.
California and Hawaiian Sugar Refining Corporation, Ltd., 215 Market St., San Francisco 5.	"Behind Your Sugar Bowl" and other informational materials, including maps, charts, and pamphlets.
California Test Bureau, 5914 Hollywood Blvd., Los Angeles 28.	"Educational Bulletins" and "Educational Reports" free of charge to teachers, in addition to descriptive catalogue of standardized diagnostic tests.
Celanese Corporation of America, 180 Madison Ave., New York 16.	Textile and plastic pamphlets and charts free to teachers.
Central Scientific Company, 1700 Irving Park Rd., Chicago 13.	"Cenco News Chats" magazine.
Cereal Institute, Incorporated. 135 South La Salle St., Chicago 3.	Bulletins and leaflets concerned with teaching aids, on cereals and man. Health education is featured.
Chicago and Southern Airlines, Municipal Airport, Memphis 2, Tenn.	An educational packet for use of teachers free on request.

Chicago Natural History Museum, Chicago 5.	Museum stories in leaflet form. Subjects have wide range of scientific interest. Listings free; leaflets, small charge.
Civil Aeronautics Administration, Aviation Education Division, Washington 25, D.C.	Lists of teaching materials and instructional aids on aviation education.
Church and Dwight Company, Inc., Department X-62, 10 Cedar St., New York 5.	Pamphlets on oral hygiene and dental care. Free colored bird cards.
Coca Cola Company, Incorporated, (See local distributor for specific local services.)	Teaching charts and descriptive science materials, devoid of advertising matter. Among topics covered are cotton, oil, steel, coal, transportation, communication.
F. E. Compton and Company, Compton's Source Materials for Schools and Teachers Series, 1000 North Dearborn St., Chicago 10.	"Community Life—The Study of Clothing." Wool, leather, rubber, fur, cotton, silk, and other materials. Objectives, activities, and subject matter.
Coors Porcelain Company, Golden, Colo.	"The Evolution of a Lump o' Clay" and other teaching materials.
Corn Products Sales Company, 17 Battery Place, New York.	"The Romance of Prairie Gold" and other teaching materials.
Cornell Rural School Leaflets, New York State College of Agriculture, Cornell University, Ithaca, N.Y.	Excellent science leaflets for use of elementary teachers. Issued several times each year. Authorative, accurate, and interestingly presented.

Cream of Wheat,
Public Relations Department,
730 Stinson Blvd.,
Minneapolis 13.

Pamphlets and food charts on the nutritional values of cereals.

Crown Zellerbach Corporation,
343 Sansome St.,
San Francisco 19.

"Growing Paper on Tree Farms," "Paper—Its Story" and other informative teaching materials.

Dairy Council of St. Louis,
4030 Chouteau Ave.,
St. Louis 10, Mo.

"The Milk Your Milkman Brings," and other pamphlets.

Dairy Institute Advisory Board,
57 Post St.,
San Francisco.

Teaching aids on human nutrition and the dairy industry.

Delta Air Lines,
Public Relations Division,
Atlanta, Ga.

Maps, bulletins, and charts on air transport free to teachers.

DeVry Corporation,
School Service Division,
1111 Armitage Ave.,
Chicago 14.

School service bulletins on audio-visual aids; bibliography and suggestions. Copies free to interested teachers.

Doubleday and Company, Inc.,
Elementary School Division,
New York.

The Nature Library Series; pictures of animals in color. Price list on request.

Douglas Fir Plywood Association,
The 500 Fifth Avenue Bldg.,
New York 18.

"Boy-size Building for Boy-size Men," "Modern Miracles in Wood," and other booklets.

E. I. du Pont de Nemours and Company, Incorporated,
Public Relations Department,
1007 Market St.,
Wilmington 98, Del.

Information, teaching materials, charts, pamphlets, and posters on rayon, nylon, and plastics free to science educators.

Eastern Air Lines, 10 Rockefeller Plaza, New York 20.	Maps, photographs, and pamphlets, including "Air Transport Facts and Figures" free to elementary teachers.
Eastman Kodak Company, Public Relations Department, Rochester 4, N.Y.	Charts, bulletins, and pamphlets on photography. Free to teachers. Also *Selected References on Photographic Visual Aids.*
Ed-U-Cards Company, 248 West 23d Street, New York.	Primary flash cards for various forms of animal life. List on request.
Evaporated Milk Association, 307 North Michigan Ave., Chicago 1.	A list of fifty pamphlet publications available free to teachers.
Firth Carpet Company, 295 Fifth Ave., New York.	A "Natural Wool Map of the World" free to elementary teachers.
Fisher Scientific Company, 717 Forbes St., Pittsburgh 19.	*The Laboratory* magazine.
Florida Citrus Commission, Public Relations Division, Lakeland, Fla.	Leaflets and pamphlets on oranges and grapefruit free to teachers.
Fruit Dispatch Company, United Fruit Company, Pier 3, North River, New York.	"Radio Bound for Banana Land," "About Bananas," and other pamphlets.
Garden Club of America, 15 E. 58th St., New York 22.	Conservation and planting leaflets and charts.

General Biological Supply House, 761–763 East 69th Pl., Chicago 37.	"Turtox News," and many excellent service leaflets free to teachers.
General Electric Company, Educational Service, Schenectady 5, N.Y.	Educational news service pamphlets and photographic enlargements free to teachers.
General Electric Company, Inquiry Bureau, Advertising Division, Lamp Department, Nela Park, Cleveland 12.	"Eyes," "The New Story of Light," "Moving the Sun," and other pamphlets available for teachers of science.
General Foods, Battle Creek, Mich.	"Cereals, One of the Basic Seven," and other pamphlets.
General Mills, Education Section, Department of Public Service, Minneapolis 1.	Pamphlets and information on suggested programs in health education free to elementary teachers on request.
General Motors Corporation, Department of Public Relations, 3044 West Grand Blvd., Detroit 2.	"Airplane Power," "Optics and Wheels," and other illustrated pamphlets on physical science materials.
Gerber Products Company, Fremont, Mich.	"Foods for Baby," "Infant Nutrition Teacher's Manual," and other materials.
H. Clay Glover Company, 101 West 31st St., New York 1.	"Our Dogs," and other pamphlets.
D. F. Goodrich and Company, Public Relations Department, Akron, Ohio.	Illustrated rubber display chart and other materials available to teachers.

Goodyear Tire and Rubber Company, Public Relations Department, Akron, Ohio.	Photographs and teaching materials on rubber free to teachers.
Greyhound Information Center, P. O. Box 815, Chicago 90.	"Highway Transportation on Parade" and other travel information.
Hayden Planetarium, 81st St. at Central Park West, New York 24.	Inexpensive star explorer charts and other materials for popular astronomy. List on request.
H. J. Heinz Company, Public Relations Department, 1052 Progress St., Pittsburgh 12.	"Manual of Foods" and other illustrated pamphlets. Charts, such as "How Spices Have Made Life More Savory." Bulletin (Quarterly): "Nutritional Observatory."
Hershey Chocolate Company, 19 East Chocolate Ave., Hershey, Pa.	Large chart and various pamphlets on chocolates free to teachers.
Household Finance Corporation, 919 North Michigan Ave., Chicago 11.	"Better Buymanship Booklets" (poultry, eggs, dairy products, fish, meat, etc.). Price list on request.
Illinois Natural History Survey, Department of Registration and Education, Urbana, Ill.	"Pleasure with Plants," and other informative pamphlets in science education.
Informative Classroom Picture Publishers, 40 Ionia Ave., N.W., Grand Rapids 2, Mich.	"How to Teach with Pictures," "The Farm" pictorial unit, and others. Catalogue on request.

International Harvester Company, Public Relations Department, 180 North Michigan Ave., Chicago 1.	"Health from the Ground Up," "Man and the Soil," "Sheep for Mutton, Wool, and Money," and other informative booklets.
International Minerals and Chemical Corporation, Box 177, Amino Products Division, 20 North Wacker Dr., Chicago 6.	"What Glutamate Does in Food" and crystal samples free to science classes.
International Paper Company, 220 East 42d St., New York 17.	"The Great Southern Tree Crop" and other forestry pamphlets.
Izaak Walton League of America, 31 North State St., Chicago 2.	Pamphlets on fishing and fish conservation free to teachers.
Kellogg Company, Home Economics Department, Battle Creek, Mich.	Charts and booklets, including "Calories in Food," "Vitamins in Food," "Food Allergies," and "Food for Growing Boys and Girls."
Knox Gelatine Company, Public Relations Department, Johnstown, N.Y.	"Gelatine Teacher's Manual" together with other bulletins and wall charts.
Kraft Cheese Company, 500 Peshtigo Court, Chicago 90.	Large wall charts and illustrated pamphlets, including "The Romance of Cheese."
Lamont, Corliss and Company, 1209 Central Ave., Hillside, N.J.	Demonstration kit: "How Chocolate Products Are Made" free to teachers on request.

Lehigh Navigation Coal Company, Philadelphia 9.	"The Wonders of Anthracite," an illustrated pamphlet on coal, free to teachers.
E. Leitz, Incorporated, 304 Hudson St., New York 13.	Charts and pamphlets on optics, cameras, and scientific instruments.
Louisiana Department of Agriculture, 541 St. Anne St., New Orleans 16.	Classroom demonstration exhibits of rice free to teachers.
Maple Flooring Manufacturers' Association, 46 Washington Blvd., Oshkosh, Wis.	Booklets and pamphlets on grading and uses of maple wood.
Metropolitan Life Insurance Company, School Service Department, 1 Madison Ave., New York 10.	An extensive series of excellent health pamphlets.
Mid-continent Airlines, Inc., 102 East Ninth St., Kansas City 6, Mo.	A special "flight packet" free to teachers, containing photographs and maps.
Miller's National Federation, Public Relations Department, 309 West Jackson Blvd., Chicago 6.	Source materials and other informative aids to health education. Free to elementary teachers.
Minnesota Mining and Manufacturing Company, Educational Department, St. Paul 6, Minn.	Pamphlets on sound recording uses in elementary education free to teachers.

Monsanto Chemical Company, Public Relations Department, 1720 South Second St., St. Louis 4.	Educational materials on chemicals and plastics, with emphasis upon scientific research methods. Bulletins and pamphlets free to science educators.
National Association of Audubon Societies, 1000 Fifth Ave., New York 28.	Free and authoritative materials for bird study.
National Canners' Association, 1739 H St., N.W., Washington 6, D.C.	"School Lunch Recipes," "Know Your Canned Foods," "Canned Foods Manual for Teaching," and other illustrated booklets.
National Confectioners' Association, 1 North La Salle St., Chicago.	A demonstration kit and colored classroom wall charts on "energy foods" free to teachers.
National Cotton Council of America, P. O. Box 18, Memphis 1, Tenn.	"Discovering Cotton," "The Age of Textiles," and other pamphlets and posters free to educators.
National Cottonseed Products Association, Educational Division, Sterick Bldg., Memphis 3, Tenn.	Booklets and informative charts on cotton and its important by-products.
National Dairy Council, 111 North Canal St., Chicago 6.	Hundreds of booklet and pamphlet publications with excellent illustrations. State grade level and unit when inquiring by mail.

National Dental Hygiene Association, Shoreham Bldg., Washington, D.C.	"A National Program for the Advancement of Dental Health," "The Army's Toothache," and other bulletins.
National Education Association, 1201 Sixteenth St., N.W., Washington 6, D. C.	"Safety through Elementary Science," an excellent booklet. Price, 50 cents.
National Federation of Textiles, Inc., 389 Fifth Ave., New York 16.	Information on rayon and other synthetic fibers.
National Garden Institute 1368 North High St., Columbus 1, Ohio.	"School Gardengrams."
National Geographic Society, Division of School Service, 16th and M Sts., Washington 6, D.C.	"Pictorial Geography" and other publication series. Complete lists of titles and prices to elementary teachers on request.
National Live Stock and Meat Board, Educational Department, 407 South Dearborn St., Chicago.	A series of classroom charts demonstrating the nutritional values and cuts of meats.
National Parks Association, 1214 Sixteenth St., N.W., Washington 6, D.C.	Charts and pamphlets on the national parks, and issues of the *National Parks* magazine.
National Recreation Association, 315 Fourth Ave., New York 10.	"Athletic Badge Tests" and other pamphlet materials integrating school play with a balanced health and hygiene program.

National Science Teachers Association, 1201 Sixteenth St., N.W., Washington 6, D.C.	Valuable teaching packets free *to members*. Elementary science series: Science Teaching Today and other excellent teaching aids.
New York Central System, Public Relations Department, 466 Lexington Ave., New York 17.	Pamphlets and still pictures demonstrating various phases of rail transportation free to teachers on request.
Northwest Airlines, Inc., 1885 University Ave., St. Paul 4, Minn.	Booklets, maps, "stickers," and illustrated post cards available free.
Oklahoma Planning and Resources Board, Capitol Office Bldg., Oklahoma City.	"Planting and Care of Forest Trees," a bulletin advocating domesticated forests as a solution to the problem of dwindling timber resources.
Pacific Lumber Company, 122 East 42d St., New York 17.	Booklets and pamphlet informational material on insulation wool and its various uses in industry.
Pan-American Coffee Bureau, 120 Wall St., New York 5.	"Coffee, the Story of a Good Neighbor Product" and other educational pamphlet materials.
Pan American World Airways, Educational Director, 135 East 42d St., New York 17.	Information concerning the air-lines operating to and from the various countries of the world. Courses of study and film library list.
Pepperell Manufacturing Company, Public Relations Department, 160 State St., Boston 2, Mass.	"Cotton from Plant to Product," free sample exhibit for elementary classrooms.

Perry Picture Company, Malden, Mass.	Pictorial catalogue of hundreds of items.
Peter Cailler-Kohler Swiss Chocolate Company, 60 Hudson St., New York.	Pictures, charts, and booklets about chocolate and cocoa.
Pittsburgh Plate Glass Company, *Public Relations* Division, 632 Duquesne Way, Pittsburgh 22.	Booklet on glass forms, manufacture, and uses in the home *free to teachers. Also* "*Color* Dynamics" instructional material.
Pillsbury Flour Mills Company, Public Relations Department, Minneapolis.	"The Story of Flour," "Fightin' Foods," and other materials.
Public Affairs Committee, Inc., 30 Rockefeller Plaza, New York.	"Who Can Afford Health," "The Fight on Cancer," and other pamphlets.
Quaker Oats Company, Advertising Department, 141 West Jackson Blvd., Chicago 4.	Nutrition charts and health food pamphlets.
Radio Corporation of America, Educational Services Division, Camden, N.J.	Educationally informative literature on radio, radar, electron microscopes, and television. Emphasis on creative research.
Revere Copper and Brass, Incorporated, 230 Park Ave., New York 17.	Pamphlets detailing the uses of copper and brass in construction projects.
Rit Products Corporation, Service Bureau, 1401 West Jackson Blvd., Chicago 7.	"How to Make Costumes for School Plays" (illustrated) booklet free to elementary teachers on request.

Save-the-Redwoods League, 250 Administration Bldg., University of California, Berkeley 4, Calif.	Illustrated pamphlets and charts on redwood uses and conservation of tree groves, free to teachers.
Science Publications, 201 North School St., Normal, Ill.	Lists of free and inexpensive commercial teaching aids. "Science Educational Service" for general science. Lists of good textbooks and manuals.
Scott, Foresman & Company, 433 East Erie St., Chicago 11.	Free pamphlets of exceptional value to teachers of upper grade science (7–8).
Shell Oil Company, Inc., Public Relations Department, 50 West 50th St., New York 20.	"This Is Oil" and "The Story of Exploration" teaching charts free to teachers on request.
Soil Conservation Service, Department of Agriculture, Washington 25, D.C.	Pamphlets and visual materials on soil conservation and proper agricultural methods.
Southern Hardwood Producers, Inc., 805 Sterick Bldg., Memphis 3, Tenn.	"Southern Oak," "The A-B-Cs of Gum," "The Southern Hardwoods," and other booklets.
Southern Pacific Lines, Public Relations Department, 310 South Michigan Ave., Chicago 4.	Informative material on transportation and southwestern United States. Maps and pamphlets free to teachers.
Southern Pine Association, Canal Bldg., New Orleans 4, La.	"Ten Lessons in Forestry," "American Southern Pine," and other booklets and pamphlets.

Southern Pulpwood Conservation Association, First National Bank Bldg., Atlanta 3, Ga.	"Where Does the Timber Go?" and other leaflets, available in limited quantities.
Southern Railway System, Public Relations Division, McPherson Sq., Washington 13, D.C.	"Pupil's Railroad Kit" free to teachers.
Standard Oil Company of California, 225 Bush St., San Francisco 20.	"The Story of Petroleum" and *other science education pamphlets.*
State Teachers' Magazines, 307 North Michigan Ave., Chicago 1.	A centralized source supplying many pamphlets and wall charts useful in science education. List free to teachers.
Sun-Maid Raisin Growers Association, Fresno, Calif.	Leaflets listing the food content, vitamins, and uses of raisins.
Swift and Company, Agricultural Research Department, Chicago 9.	Elementary science booklets: "The Story of Soil," "The Story of Plants," "The Story of Meat Animals," etc., free in quantity.
Tanners' Council of America, Inc., 100 Gold St., New York 7.	"The Romance of Leather" and other informative materials free to teachers.
Taylor Instrument Company, Public Relations Department, Rochester 1, N.Y.	"What Do You Know about the Weather?" booklet free to elementary school teachers considering weather units.

Teachers' Material Service, New Bedford, N.Y.	Actual samples of science teaching materials (chocolate, coal, fishing, minerals, paper, etc.). Price list on request.
Texas Gulf Sulphur Company, 75 East 45th St., New York.	"Modern Sulphur Mining" educational pamphlet free to elementary school teachers.
The Thomas Alva Edison Foundation, Inc., Main St. at Lakeside Ave., West Orange, N.J.	"The Incandescent Light" booklet.
Training Aids, Incorporated, 7414 Beverly Blvd., Los Angeles 56.	Sets of training cards for child recognition of birds, dogs, and other animals. List of publications on request.
Transcontinental and Western Air Lines, Public Relations Department, 10 Richard Rd., Kansas City, Mo.	Pamphlets, maps, and picture post cards, together with air timetables, free on request.
Trans-World Airline, Educational Services, 101 West 11th St., Kansas City 6, Mo.	Maps, pamphlets, and other educational materials free to teachers.
Union Bag and Paper Corporation, Woolworth Bldg., New York 17.	"Pulpwood, Key to Sustained Forest Income" and other free educational pamphlets.
Union Carbide and Carbon Corporation, Public Relations Department, 30 East 42d St., New York 17.	Information concerning chemicals, carbons, and plastics; their uses in science and in industry. Free booklet, "Products and Processes."

United Air Lines, School and College Service, Address the nearest office: 80 East 42d St., New York 17. 35 East Monroe St., Chicago 3. 6th and Olive Sts., Los Angeles 14. 400 Post St., San Francisco 2. 1225 Fourth Ave., Seattle 1.	An "elementary school bibliography" booklet: "How Representative Grade Teachers Are Teaching Aviation." Bulletin board materials and teaching aids, motion-picture films available on a free loan basis. Pictures of historic planes, timetables, air maps, air-express folders, color prints, and other excellent aids for science education, all free to teachers. Send for free list and order blank, giving information regarding the grade level for which the informative aids are to be used.
United States Beet Sugar Association, Washington 5, D.C.	"A Story of Sugar" booklet free to teachers.
U.S. Department of Agriculture, Division of Publications, Office of Information, Washington 25, D.C.	*List of Available Publications of United States Department of Agriculture* containing complete titles and order numbers of publications free and for sale.
U.S. Department of Commerce, Weather Bureau, Washington 25, D.C.	Weather maps and cloud formation pictures free to teachers.
U.S. Forest Service, Department of Agriculture, Washington 25, D.C.	"Material of Interest to Teachers" listing many pamphlets and leaflets. Ten copies of any published item free; small charge made for additional copies.

U.S. Government Printing Office, Division of Public Documents, Washington 25, D.C.	"Fish and Wild Life," "Education," "Health," and price lists of other government publications, sent free upon request.
United States Pulp Producers Association, 122 East 42d St., New York 17.	"Wood Pulp, a Basic American Industry," an educational booklet.
United States Rubber Company, Rockefeller Center, 1230 Avenue of the Americas, New York 20.	"Serving through Science," a booklet of authoritative presentations in the language of the layman on current science topics.
United States Steel Corporation, Department of Research and Public Relations, 429 Fourth Ave., Pittsbutgh 19.	Pamphlet series, "Science in Steelmaking" free to educators.
Wallace and Tierman Company, Public Relations Department, Newark 1, N.J.	"Swimming Pools and Other Bathing Places," "Chlorination," and other illustrated pamphlets.
Ward's Natural Science Establishment, Box 24, Beechwood Stations, Rochester 9, N.Y.	"Ward's Natural Science Bulletin" and other publications free to teachers upon request.
West Coast Woods, West Coast Lumbermen's Association, 1410 S.W. Morrison St., Portland 5, Ore.	"Be Sure When You Build," "Four of the World's Finest Woods," and other pamphlets.

Western Association of Railway Executives, Public Relations Department, 105 West Adams St., Chicago 3.	Pictures, teachers' manual, and instruction kit on rail transportation.
Western Pine Association, Yeon Bldg., Portland 4, Ore.	Pamphlets about pines, firs, cedars, and spruce. Single copies free; quantity price lists on request.
Westinghouse Electric and Manufacturing Company, School Service, 306 Fourth Ave., Pittsburgh 30.	An extensive series of excellent illustrated booklets, large charts, and colored poster teaching aids. Available free in quantity.
Weyerhaeuser Sales Company, P.O. Box 629, Newark, N.J.	"We Grow Trees," "Timber Is a Crop," and other pamphlets free to teachers.

CLASSIC NATURE ART FOR THE PRIMARY-ELEMENTARY CLASSROOM

ARTIST	SUBJECT
Ahl	*Marine*
Baer	*The Bird's Nest*
Benson	*The Frightened Ducks*
Bickford	*Lilies*
Blinks	*Steady*
Bonheur	*Cattle of Brittany*
——	*Horses*
——	*The Horse Fair*
——	*The Sheepfold*
Braith	*At the Watering Place*
Breton	*The Song of the Lark*
Chandler	*Giraffes*
Constable	*The Corn Field*
Corot	*Scene by a Brook*
——	*Spring*
——	*The Lake*
——	*Woodland Path*
Cotard	*Young Roosters*
Courbet	*The Deer Retreat*
Couse	*Indian Harvest*
——	*Indian Shepherd*
——	*The Brook*
——	*The Voice of the Falls*
Cunco	*Threshing Time*
Dahmen	*Little Mother*
Davil	*Large White Cat*
de Renne	*The Hounds*
Denslow	*Humming Birds*
Ferris	*The First Thanksgiving*
Fosberry	*Supper*

Artist	Subject
Friedrich	*Forest of Tall Trees*
Friese	*Deer in the Woods*
———	*Head of a Tiger*
Graffe	*Blue Crab*
Grassel	*Returning Geese*
———	*Spring Morning*
Haller	*Luna Moth*
Hein	*Morning in the Forest*
Hergenbarth	*Horses*
Holmes	*Can't You Talk*
Horsfall	*Raccoon*
———	*The Great Blue Hen*
Hunt	*Dog Home*
———	*Twin Lambs*
Innes	*Autumn Oaks*
———	*Morning in the Meadow*
———	*Morning on the Hudson*
———	*Peace and Plenty*
———	*Spring*
Kappstein	*Birds on the North German Shore*
Keith	*California in Springtime*
Kerschensteiner	*Elephants*
Koester	*Ducks*
Landseer	*Distinguished Member of Humane Society*
Le Roy	*Black and White Beauties*
Lippincott	*The Last of the Snow*
Longhammer	*Evening Glow*
Lucas	*Harvest Time*
Maris	*Feeding the Chickens*
———	*In the Poultry Yard*
Millet	*Feeding the Birds*
Petite	*The River Turtle*
Potter	*Cattle in Pasture*
Rich	*Family of Polar Bear*
Roloff	*In Flower*
Ronner	*Pussy on the Warpath*
Russell	*Child with Cherries*
Smith	*The Fairy Pond*
Thaulow	*Snow Scene*

Artist	Subject
Trovar	*Return to the Farm*
Van Marche	*On the Marshes*
Verhas	*On the Beach*
Verschuier	*In the Stable*
Wiggins	*Down the Lane at Twilight*
Zugel	*Dogs*
———	*Driven Home*
———	*Through the Water*

CONSERVATION OF NATURAL RESOURCES AGENCIES

Federal

Agricultural Extension Service, U.S. Department of Agriculture, Washington 25, D.C.

Bureau of Biological Survey, U.S. Department of Agriculture, Washington 25, D.C.

Bureau of Fisheries, U.S. Department of Commerce, Washington 25, D.C.

Bureau of Reclamation, U.S. Department of the Interior, Washington 25, D.C.

Fish and Wildlife Service, U.S. Department of the Interior, Washington 25, D.C.

National Park Service, U.S. Department of the Interior, Washington 25, D.C.

Office of Education, Federal Security Agency, Washington 25, D.C.

Soil Conservation Service, U.S. Department of the Interior, Washington 25, D.C.

U.S. Forest Service, Division of Information and Education, U.S. Department of Agriculture, Washington 25, D.C.

State

Divisions of Fish and Game, State Departments of Natural Resources.

Divisions of Forestry, State Departments of Natural Resources.

Divisions of Mines, State Departments of Natural Resources.

Divisions of Oil and Gas, State Departments of Natural Resources.

Divisions of Parks, State Departments of Natural Resources.

Divisions of Water Resources, State Departments of Public Works.

State Departments of Education, Address: State Superintendent of Public Instruction.[1]

Alabama State Department of Conservation, 5 North Bainbridge St., Montgomery 4, Ala.

Arizona Wildlife Federation, University of Arizona, Tucson, Ariz.

California Conservation Council, 912 Santa Barbara St., Santa Barbara, Calif.

California Division of Fish and Game, Ferry Bldg., San Francisco 11, Calif.

Connecticut Forest and Park Association, 839 Chapel St., New Haven 6, Conn.

Kansas Forestry, Fish and Game Commission, Pratt, Kans.

Michigan State Department of Conservation, State Office Building, Lansing 13, Mich.

Minnesota Conservation Department, State Office Bldg., St. Paul 1, Minn.

Mississippi Game and Fish Commission, Pearl and South Congress Sts., Jackson, Miss.

Missouri Conservation Federation, 648 East Big Bend Rd., Webster Grove 19, Mo.

Montana Forestry Service, Federal Bldg., Missoula, Mont.

Nebraska Conservation Foundation, Sixteenth and Farnam Sts., Omaha, Nebr.

Nevada Fish and Game Commission, Carson City, Nev.

North Carolina Division of Game and Inland Fisheries, Raleigh, N. C.

North Dakota Game and Fish Department, State Capitol Bldg., Bismarck, N. D.

Oklahoma Planning and Resources Board, State Capitol Bldg., Oklahoma City 5, Okla.

Pennsylvania Game Commission, Harrisburg, Pa.

Pennsylvania Forestry Association, Commercial Fruit Bldg., Philadelphia 2, Pa.

South Carolina State Commission of Forestry, State Office Bldg., Columbia, S. C.

Tennessee Conservation Commission, Nashville, Tenn.

[1] For example, *Conservation and Nevada*, Nevada State Department of Public Instruction, Carson City, Nev., 1949.

National

American Forest Products Industries, 1319 Eighteenth St., N.W., Washington 6, D.C.

American Forestry Association, 919 Seventeenth St., N.W., Washington 6, D.C.

American Nature Association, 1214 Sixteenth St., N.W., Washington 6, D.C.

The American Nature Study Society, P.O. Box 1078, Chapel Hill, N.C

Boy Scouts of America, 2 Park Ave., New York 16.

California Redwood Association, 250 Administration Bldg., University of California, Berkeley 4, Calif.

Conservation Foundation, 30 East Fortieth St., New York 16.

Friends of the Land, 1368 North High St., Columbus 1, Ohio.

Game Conservation Society, Incorporated, 1819 Broadway, New York 23.

Garden Club of America, Conservation Committee, 15 E. 58th St., New York 22.

Girl Scouts of America, 155 East 44th St., New York 17.

Inland Bird Banding Association, St. Joseph's College, Collegeville, Ind.

Izaak Walton League of America, 31 North State St., Chicago 2.

National Association of Audubon Societies, 1000 Fifth Ave., New York 28.

National Wildlife Federation, 3308-14th St., N.W., Washington 10, D.C.

Migratory Bird Conservation Commission, Department of the Interior Bldg., Washington 25, D.C.

National Georgraphic Society, Sixteenth and M Sts., N.W., Washington 6, D.C.

National Wildlife Society, 3308 Fourteenth St., N.W., Washington 10, D.C.

Save-the-Redwoods League, 114 Sansome St., San Francisco 4.

Society of American Foresters, 17th St. and Pennsylvania Ave., N.W., Washington 6, D.C.

Wild Flower Preservation Society, 3740 Oliver St., Washington 15, D.C.

Wilderness Society, 1840 Mintwood Pl., N.W., Washington 9, D.C.

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California Division of Fish and Game, Ferry Bldg., San Francisco 11, Calif.

Connecticut Forest and Park Association, 839 Chapel St., New Haven 6, Conn.

Kansas Forestry, Fish and Game Commission, Pratt, Kans.

Michigan State Department of Conservation, State Office Building, Lansing 13, Mich.

Minnesota Conservation Department, State Office Bldg., St. Paul 1, Minn.

Mississippi Game and Fish Commission, Pearl and South Congress Sts., Jackson, Miss.

Missouri Conservation Federation, 648 East Big Bend Rd., Webster Grove 19, Mo.

Montana Forestry Service, Federal Bldg., Missoula, Mont.

Nebraska Conservation Foundation, Sixteenth and Farnam Sts., Omaha, Nebr.

Nevada Fish and Game Commission, Carson City, Nev.

North Carolina Division of Game and Inland Fisheries, Raleigh, N. C.

North Dakota Game and Fish Department, State Capitol Bldg., Bismarck, N. D.

Oklahoma Planning and Resources Board, State Capitol Bldg., Oklahoma City 5, Okla.

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Pennsylvania Forestry Association, Commercial Fruit Bldg., Philadelphia 2, Pa.

South Carolina State Commission of Forestry, State Office Bldg., Columbia, S. C.

Tennessee Conservation Commission, Nashville, Tenn.

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Wild Flower Preservation Society, 3740 Oliver St., Washington 15, D.C.

Wilderness Society, 1840 Mintwood Pl., N.W., Washington 9, D.C.

DRAMATIC PLAYLETS USEFUL IN PRIMARY-ELEMENTARY SCIENCE EDUCATION[1]

ANIMAL LIFE

"Bird Day," from *Special Day Pageants for Little People*, by Kennedy, Marion, and Bemis, K. I., Barnes & Noble, Inc., New York. Grades 1–4.

'Bird's Nest," from *Little Dramas for Primary Grades*, by Skinner, A. M., and Lawrence, L. M., American Book Company,. New York. Grades 1–2.

"Bird's Story of the Trees," from *Plays for School Children*, by Lutkenhaus, A. M., Appleton-Century-Crofts, Inc., New York. Grades 6–8.

"Blue Bird," from *The Blue Bird, a Fairy Play in Six Acts*, by Teixeirade, Mattos, Dodd, Mead & Company, Inc., New York Grades 7–8.

"Child and the Sparrow," from *Little Dramas for Primary Grades*, by Skinner, A. M., and Lawrence, L. M., American Book Company, New York. Grades 1–2.

"Firefly Night," from *Fairyland and Footlights*, by Jagendorf, M. A., Brentano's, 586 Fifth Ave., New York 19. Grades 5–7.

"Frog Fairy," from *Harper's Book of Little Plays*, by Barnum, M. D., Harper & Brothers, New York. Grades 4–6.

"Goats in the Turnip Field," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Guest of the Butterfly," from *Five Plays and Five Pantomimes*, by Baldwin, Sidney, The William Penn Publishing Corp., New York. Grades 3–5.

"Ladybird," from *A Book of Plays for Little Actors*, by Johnston, E. I., and Barnum, M. D., American Book Company, New York. Grades 2–3.

[1] Listed by subject titles, to facilitate selection.

"Little Fish," from *Children's Classics in Dramatic Form*, Vols. 1–5, by Stevenson, Augusta, Houghton Mifflin Company, Boston. Grades 1–2.

"Little Robin Stay-behind," from *Little Robin Stay-behind, and Other Plays in Verse for Children*, by Bates, K. L., Woman's Press, New York Grades 5–6.

"Mabel and the Green Lizard," from *Little Dramas for Primary Grades*, by Skinner, A. M., and Lawrence, L. M., American Book Company, New York. Grades 1–2.

"Magic Sea Shell," from *Indoor and Outdoor Plays for Children*, by Farrar, J. C., Noble & Noble, Publishers, Inc., New York. Grades 5–7.

"Miss Ant, Miss Grasshopper, and Mr. Cricket," from *Patchwork Plays*, by Field, R. L., Doubleday & Company, Inc., New York. Grades 3–6.

"Mr. Rabbit's Easter Jamboree," from *Magic Strings*, by Bufano, Remo, The Macmillan Company, New York. Grades 5–8

"Mrs. White Hen's Mistake," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Professor Frog's Lecture," from *Children's Plays*, by Skinner, E. L., and Skinner, A. M., Appleton-Century-Crofts, Inc , New York. Grades 4–5.

"Sparrow and the Bush," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Spider and the Fly," from *A Book of Plays for Little Actors*, by Johnston, E. L., and Barnum, M. D., American Book Company, New York. Grades 2–3.

"What Was in Mrs. White Hen's Nest," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Why the Jelly Fish Has No Shell," from *Little Dramas for Primary Grades*, by Skinner, A. M., and Lawrence, L. M., American Book Company, New York. Grades 1–2.

Conservation of Natural Resources

"Arbor Day or Bird Day in the Woods," from *New Plays for Every Day the Schools Celebrate*, by Niemeier A. M., Noble & Noble, Publishers, Inc., New York. Grades 5–6.

"Conservation, Pageant 1," from *Programs for Special Occasions*

for Primary Grades, by Kennedy, Marion, and Bemis, K. I., A. S. Barnes and Company, New York. Grades 1–4.

"Conservation, Pageant II," from *Programs for Special Occasions for Primary Grades*, by Kennedy, Marion, and Bemis, K. I., A. S. Barnes and Company, New York. Grades 1–4.

"Conservation, Pageant III," from *Programs for Special Occasions for Primary Grades*, by Kennedy, Marion, and Bemis, K. I., A. S. Barnes and Company, New York. Grades 1–4.

"Discontented Pine Tree," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Fighting a Forest Fire," from *Citizenship Plays*, by Hubbard, Eleanore, Benj. H. Sanborn & Co., Chicago. Grades 5–8.

"Masque of Conservation," from *The Forest Princess and Other Masques*, by Mackay, C. D., Henry Holt and Company, Inc., New York. Grades 5–7.

"Pine Tree," from *Fairy Plays for Children*, by Goodlander, M. B., Rand McNally & Company, Chicago. Grades 3–4.

"Prayer of the Forest Spirit," from *Holiday Plays for Home, School, and Settlement*, by Olcott, Virginia, Dodd, Mead & Company, Inc., New York. Grades 5–7.

"Save That Tree," from *School Auditorium Programs*, by Burke, P. J., Beckley-Cardy Company, Chicago. Grades 5–7.

Health and Hygiene

"Angel's Holiday," from *Plays for Spring and Summer Holidays*, by Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 4–6.

"Bay of Fresh Air Dreams," from *Dramatizing Child Health*, by Hallock, C. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 4–5.

"Birthday Party," from *To Read and to Act*, by Stratton, Clarence, McGraw-Hill Book Company, Inc., New York. Grades 7–8.

"Christmas Candles," from *Rehearsal for Safety*, by Cannon, F. V., E. P. Dutton & Co., Inc., New York. Grades 5–8.

"Clean Up!," from *Plays for Festivals*, by Schauffler, R. H., and Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 6–8.

"David and the Good Health Elves," from *Little Plays for Little People*, by Sanford, A. P., and Schauffler, R. H., Dodd, Mead & Company, Inc., New York. Grades 3–5.

"Fantasy of Foods," from *Little Plays for Little People*, by Sanford, A. P., and Schauffler, R. H., Dodd, Mead & Company, Inc., New York. Grades 4–6.

"First Crop of Apples," from *Historical Plays for Colonial Days for Fifth Year Pupils*, by Tucker, L. E., Longmans, Green & Co., Inc., New York. Grades 5–6.

"Happiness Street," from *Plays for Civic Days*, by Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 6–8.

"Health Brownies," from *Puppet Plays for Children*, by Everson, F. M., Beckley-Cardy Company, Chicago. Grades 6–8.

"House That Health Built," from *Dramatizing Child Health*, by Hallock, G. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 4–5.

"How Prince Joy Was Saved," from *Dramatizing Child Health*, by Hallock, G. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 5–6.

"Little Vegetable Men," from *Dramatizing Child Health*, by Hallock, G. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 4–6.

"Trip to Healthland," from *Dramatizing Child Health*, by Hallock, G. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 4–7.

"Weaver of Dreams," from *Dramatizing Child Health*, by Hallock, G. J., American Child Health Assn., 450 Seventh Ave., New York. Grades 4–6.

Physical Science

"Benjamin Franklin," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Forewarned Is Forearmed," from *Citizenship Plays*, by Hubbard, Eleanore, Benj. H. Sanborn & Co., Chicago. Grades 5–6.

"Lady Moon," from *Little Dramas for Primary Grades*, by Skinner, A. M., and Lawrence, L. M., American Book Company, New York. Grades 3–4.

"Man Who Read the Stars," from *Classroom Plays from Canadian History*, by Stephen, A. M., J. M. Dent & Sons, Ltd., Toronto 5, Canada. Grades 5–8.

"Months," from *A Treasury of Plays for Children*, by Moses, W. J., Little, Brown & Company, Boston. Grades 7–8.

"Moon," from *Nine New Plays for Children*, by Fylemen, Rose, C. C. Nelson Publishing Company, Appleton, Wis. Grades 4–6.

"Mr. Sun and Mr. Wind," from *New Plays for Children*, by Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 4–6.

"North Wind at Play," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Prince of the Moon," from *Sweet Times and the Blue Policeman*, by Young, Stark, Henry Holt & Company, Inc., New York. Grades 5–6.

"Rainbow Robe," from *Household Plays for Young Children*, by Olcott, Virginia, Dodd, Mead & Company, Inc., New York. Grades 6–8.

"Scarecrow Who Wished for the Moon," from *The Ragamuffin Marionettes*, by Warner, F. L., Houghton Mifflin Company, Boston. Grades 4–5.

"Seasons," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Snow Queen," from *Plays for Festivals*, by Schauffler, R. H., and Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 6–8.

"Spirit of the Frost," from *Five Plays and Five Pantomimes*, by Baldwin, Sidney, The William Penn Publishing Corp., New York. Grades 3–5.

"Stars of Destiny," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Story of Dynamite," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Transcontinental Journeys," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Troubles of Snowman," from *New Plays for Children*, by Sanford, A. P., Dodd, Mead & Company, Inc., New York. Grades 4–5.

"When the Sun Rises," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

"Wind," from *The Child Lore Dramatic Playlet*, by Bryce, C. T., Charles Scribner's Sons, New York. Grades 1–2.

Plant Life

"Arbor Day," from *A Book of Plays for Little Actors*, by Johnston, E. L., and Barnum, M. D., American Book Company, New York. Grades 2–3.

"Boastful Bamboo Tree," from *Little Dramas for Primary Grades*, by Skinner, L. A., and Lawrence, L. M., American Book Company, New York. Grades 1–2.

"Charter Oak," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Corn Husking in the Middle West," from *Playmaking and Plays*, by Merrill, John, and Fleming, Martha, The Macmillan Company, New York. Grades 7–8.

"Flower Show," from *Programs for Special Occasions for Primary Grades*, by Kennedy, Marion, and Bemis, K. I., A. S. Barnes and Company, New York. Grades 1–4.

"Jack-in-the-pulpit Is Preaching To-day," from *New Plays for Every Day the Schools Celebrate*, by Niemeier, A. M., Noble & Noble, Publishers, Inc., New York. Grades 4–6.

"Key Flower," from *International Plays for Young People*, by Olcott, Virginia, Dodd, Mead & Company, Inc., New York. Grades 5–7.

"Little Christmas Tree," from *Little Dramas for Primary Grades*, by Skinner, L. A., and Lawrence, L. M., American Book Company, New York. Grades 1–2.

"Luther Burbank," from *The Cavalcade of America*, by Fox, D. R., and Schlesinger, A. M., Milton Bradley Company, Springfield, Mass. Grades 5–8.

"Marjorie's Garden," from *Five Plays and Five Pantomimes*, by Baldwin, Sidney, The William Penn Publishing Corp., New York. Grades 4–6.

"Nature Play in a City School," from *Plays for School Children*, by Lutkenhaus, A. M., Appleton-Century-Crofts, Inc., New York. Grades 6–8.

"Park Is a Jungle," from *Magic Strings*, by Bufano, Remo, The Macmillan Company, New York. Grades 6–8.

"Pot of Gold," from *Children's Classics in Dramatic Form*, Vols. 1–5, by Stevenson, Augusta, Houghton Mifflin Company, Boston. Grades 6–8.

"Seedlings," from *Plays for School Children*, by Lutkenhaus, A. M., Appleton-Century-Crofts, Inc., New York. Grades 5–7.

ELEMENTARY SCHOOL SONGS ABOUT NATURE

Selected Songbooks and Songs, Alphabetically Arranged

Song Titles

Merry Music, A Singing School series, edited by Theresa Armitage, Peter W. Dykema, and Gladys Pitcher, C. C. Birchard and Company. Grades 2-4.

April Warning, An
Country Circus, The
Country Road
Drip, Drip
Farmer, The
First Spring Days
Five Fat Turkeys
From Sheep to Sweater
From Wheat to Bread
Garden Musician, A
Harvest Moon
I'm a Duck
My Good Old Dog
North Wind
Silver Maple Leaves
Song Sparrow
Squirrel Town
Tree Toad, The
Twilight Song
Under the Table Manners
Water Lilies
Waterproof Gowns
Zoo, The

Music Everywhere, A Singing School series, edited by Theresa Armitage, Peter W. Dykema, Gladys Pitcher, David Stevens, and J. Lilian Vandevere, C. C. Birchard and Company. Grades 5-6.

American Eagle
Autumn Song, An
Cat and the Catboat
Chickadee
County Fair
Fisher Sails Away
Forest Ranger, The
House in the Willows
La Cucaracha
Ladybird
Night Herding Song
Noah's Ark

Over the Meadows
Snail, The
Spring Victorious
Summer Is A'Comin' In
Thar She Blows
Weather
White Dove, The

New Music Horizons, Second Book, edited by Osbourne McConathy, Russell V. Morgan, James L. Mursell, Mabel E. Bray, W. Otto Miessner, and Edward B. Birge. Silver Burdett Company. Grades 1–2.

Baa, Baa, Black Sheep
Bunny Rabbit
Bushy Tail
Busy Bee
Buttercup
Chant of the Chipmunk
Chick-A-Biddy
Dear Little Violet
Down in the Garden
Farmyard Pets
Geese
Glowworm, The
Good-by to Winter
Grasshopper Green
Growly Bear
I'm Off to the Woods
May Baskets
May Flowers
Mr. Sun
Over the River and through the Wood
Rooster, The
Three Little Ducks
Three Little Trees
What Is the March Wind Saying?

New Music Horizons, Third Book, edited by Osbourne McConathy, Russell V. Morgan, James A. Mursell, Marshall Bartholomew, Mabel E. Bray, W. Otto Miessner, and Edward B. Birge. Silver Burdett Company. Grades 2–4.

Bee, The
Cat, The
Clouds
Flies
Horses of Magic
In the Park
Little Dove, The
Little Robin Redbreast
Long-eared Owl
Mockingbird, The
My Little Brown Hen
My Merry Canary
My Pony
Pioneers
Pop! Goes the Weasel
Rabbit, The
Rover
Sea Horse
Song of the Birds
Tadpoles
Three Blind Mice
To the Fox
Turkey Game, The
Two Little Crabs
Where Do All the Daisies Go?
Whippoorwill
Why the Ant Is Shabby
Wind's Song, The

New Music Horizons, Fourth Book, edited by Osbourne McConathy, Russell V. Morgan, James L. Mursell, Marshall Bartholomew, Mabel E. Bray, W. Otto Miessner, and Edward B. Birge. Silver Burdett Company. Grades 3-5.

Birds' Conversation, The
Birds' Nest, The
Blow Away the Morning Dew
Brother Robin
Butterflies
Chanticleer
Farmyard Song
Fun at the Zoo
Groundhog
Horses in the Field
How the Corn Grows
How Grows the Bulb
Hush! The Waves Are Rolling In
I Plant Some Rice
John and Rabbit
John's Beautiful Horse
Little White Lamb
Lost Lamb, The
Mister Fox
Mr. Squirrel's Wedding
My Lambs and My Sheep
Oranges and Lemons
Sparrow in the Eaves, The

New Music Horizons, Fifth Book, edited by Osbourne McConathy, Russell V. Morgan, James L. Mursell, Marshall Bartholomew, Mabel E. Bray, W. Otto Miessner, and Edward B. Birge. Silver Burdett Company. Grades 4-6.

Ash Grove, The
Bird Calls
Birds and Flowers
Cow, The
Fish Tale, A
Flower in My Garden
Frog and the Crow, The
Hear That Old Rooster Crowing!
Morning Sunshine
Nightingale
Old Zip Coon
Onward the Brook
Orchard Song
Paul and the Fox
Peacock, The
Pigeons, The
Red Iron Ore
Sheep on the Hillside
Shoo, Fly, Don't Bother Me!
Song of the Ants
South Wind and the Rose, The
Whale Song, The
What Kind of Flower?
Woods Are Hushed, The

New Music Horizons, Sixth Book, edited by Osbourne McConathy, Russell V. Morgan, James L. Mursell, Marshall Bartholomew, Mabel E. Bray, W. Otto Miessner, and Edward B. Birge. Silver Burdett Company. Grades 5-6.

Ah, Lovely Meadows
All in a Garden Green
Autumn Song of the Birds
Cockles and Mussels
Cuckoo Sounds His Call
Daisies
Desert Song
Forester's Song
Garden Song
Herons Homeward Flying
Lark's Song, The
Last Rose of Summer, The
Listen to the Mockingbird
Meadow Butterfly
Mountain Stream
My Beautiful Forest
Nightingale Song
Owl and the Pussycat, The
Return of the Birds
Seasons Come, the Seasons Go, The
Soft-shell Crab, The
Swallows Are Homing, The
Three Apples
Ugly Duckling, The
Wind among the Trees, The

Our Land of Song, A Singing School Series, edited by Theresa Armitage, Peter W. Dykema, Gladys Pitcher, David Stevens, and J. Lilian Vandevere. C. C. Birchard and Company. Grades 4–6.

Autumn
Autumn Evening
Bees in Winter
Break of Day, The
Carol of the Creatures
Clever Cricket
Cobbler and the Crow
Come, Lovely May
Elephant's Lullaby
First Star
Fog
For a Rainy Day
Forest Green
In the Woods
Little Pig
O Robin, Come
O'er the Hills Away
Pastorale
Peep!
Ride a Sea Horse
Rushing River
Sea Gull
South Wind
Wait, Old Mule
Windy Nights

Our Songs, A Singing School series, edited by Theresa Armitage, Peter W. Dykema, and Gladys Pitcher. C. C. Birchard and Company Grades 1–3.

All in the Tree
Ant Reporter Interviews the Bees
Big Brown Bear
Butterflies
Come, Little Chipmunk
Donkey Music
Funny Bunny

Geese
Gray Squirrel
Hop, Little Frog
How They Grow
Lambkin, The
Little Brown Bug
Little Bunny Hops
Little Turtle
March Wind
Miss Chicadee
Noisy Bird, A
Rainbow
See That Elephant
Song of the Corn
Storm Clouds
Summer Lullaby
Tale of the Tailless Rabbit, The
Trot, Trot, Trot
What I Like
Who Has Seen the Wind?
Woodpecker, The
Young Puss

Songs of Many Lands, The World of Music series, edited by Maybelle Glenn, Helen S. Leavitt, Victor L. F. Rebmann, and Earl L. Baker, Ginn and Company. Grades 4–5.

At the Pasture Bars
Autumn Wind
Bluebells and Fairies
Brook, The
Bumblebee, A
By the Stream
Cherry Blossoms
Cobweb Cradles
Crickets for Luck
Fisherman's Song
Flower Girl, The
Flower Seeds
Friendly Toad, The
Gardening
Little Lady Rose
Little Turtle, The
Mowing the Barley
Snow Time
Spring Messengers
Summer Song, A
Three Ponies
Wild Wings

The American Singer series, Book Two, edited by John W. Beattie, Josephine Wolverton, Grace V. Wilson, and Howard Hinga, American Book Company. Grades 1–3.

Airplane, The
Animal Friends
Bear Came, The
Bee and the Ant, The
Bird's Chorus, The
Butterfly, The
Carrier Pigeon, The
Chicken Talk
Clouds
Cock-a-doodle-doo
Cuckoo, The
Dandelion
Dandelion Seed
Elephant, The
Flowers' Lullaby, The
Frogs at Night
Little Birds' Ball
Mister Bear
My Dog and I
"No, No, Mister Bear"

Old Dobbin
On the Seashore
Our Rosebush
Rabbit Came, The
Squirrel's Eyes, The
Trees in Autumn

The American Singer series, Book Three, edited by John W. Beattie, Josephine Wolverton, Grace V. Wilson and Howard Hinga, American Book Company. Grades 2–4.

Autumn Is Here
Birdie
Birds' Skyway, The
Cardinal, The
Flowers for Mother
Frost Pictures
Gardening
Gardens in the Sea
High-stepping Horses
In Your Nest
It Rained a Mist
Lady Bug
Little Creek
Morning Glories
My Mocking Bird
Polliwog
Pony Ride
Rain
Seasons, The
Shoo, Fly
Turtle, The
Welcome, O Birds
Zebra and Tiger

The American Singer series, Book Four, edited by John W. Beattie, Josephine Wolverton, Grace V. Wilson, and Howard Hinga, American Book Company. Grades 3–4.

Bears' Lullaby
Birch Tree, The
Bird and Flower
Bird Dreams
Contrary Owl, The
Early Frost
Frog and Owl
Frog Went a-Courtin'
Goat Kid, The
Ground-hog Day
How Creatures Move
Humming Bird
King Rooster
Little Pine Tree
Mr. Bullfrog
Northern Swans
Old Fisherman
Penguin, The
Polar Bear
Sad Mother Nature
Sea Shell
Trees in Winter
White Butterflies

The American Singer series, Book Five, edited by John W. Beattie, Josephine Wolverton, Grace V. Wilson and Howard Hinga, American Book Company. Grades 4–6.

April Rain
Armadillo, The
Birds' Courting Song
Blue Flowers
Brooklet, The
Camel, The
Cardinal and Robin
Fisherman, The
Fly, Bird, Fly
Fly, Eagle
Friendly Cricket, The
Had a Little Dog
Herons
Humming Bird, The
Llama, The
My Goose
My Horses Ain't Hungry
My Husky Dog
Nature's Praise
Planets, The
Spotted Crow, The
Wedding of the Fleas
Weevily Wheat

The American Singer series, Book Six, edited by John W. Beattie, Josephine Wolverton, Grace V. Wilson and Howard Hinga, American Book Company. Grades 5–6.

Autumn Holiday
Blue Duck, The
Brooklet, The
Cardinal, The
Cherry Tree Carol
Come, Gentle Spring
Crab, The
Dandelion
Forest Music
Lilacs in the Rain
Mist and All, The
Reaping Song
Salerno Fisherman
Shepherd Boy, The
Shy Violet
Smiling Spring
Song of the Pigeon
Sunrise
Tall Pine Tree
Trout, The

Tunes and Harmonies, The World of Music series, edited by Maybelle Glenn, Helen S. Leavitt, Victor L. F. Rebmann, and Earl L. Baker, Ginn & Company. Grades 5–6.

Animal Store, The
Apple Tree, The
Bird Walk, A
Cherry Blooms
Cherry Ripe
Down to the Sea
Fruit Trees
Italian Garden
Kings of the Sea
Message of Spring
Mountain Blizzard
North Wind
Papaya Tree, The
Pine Needles
Rose, The
Song of a Garden
Sun and Rain
Swallow and the Maiden, The
To an Eagle
Tree's Secret, The
Under the Cherry Tree
When Poppies Close Their Eyes
Where the Crane Flies

We Sing, A Singing School series, edited by Theresa Armitage, Peter W. Dykema, and Gladys Pitcher, C. C. Birchard and Company. Grades 3–5.

Arbor Day
Autumn
Bees' Party, The
Busy Birds
Cherries
Come Back Again in June
Concerning Crocuses
Flowers in May
Garden Sleeps, The
Gay October
Hedge Rose, The
In the Rain
Kangaroo, The
Lark in the Morn
Little Owl
Little White Dove
Precocious Piggy
Quack, Quack, Said the Duck
Robins, The
Rose, The
Sea Gulls
Song of the Meadowlark
Sparrow in the Garden
Sweet Nightingale
Tree in the Wood, The
Winds of November

GRADED ELEMENTARY SCIENCE READERS

SELECTED SCIENCE READERS—GRADE 1

Beim, Louise: *Benjamin Busybody*, Harcourt, Brace and Company, Inc., New York, 1947.

Bianco, M.: *The Good Friends*, The Viking Press, Inc., New York, 1934.

——: *More about Animals*, The Macmillan Company, New York, 1934.

Bowen, Vernon: *The Lazy Beaver*, David McKay Company, Philadelphia, 1948.

Brown, Margaret W.: *The Golden Egg Book*, Simon and Schuster, Inc., New York, 1947.

Colman, Margery: *Bramble*, Coward-McCann, Incorporated, New York, 1948.

Craig, G. S., and Burke, A.: *We Look about Us*, Ginn & Company, Boston, 1935.

—— and ——: *Science All about Us*, Ginn & Company, Boston, 1946.

——, ——, and Babcock, M. F.: *We Want to Know*, Ginn & Company, Boston, 1941.

Dombrowski, B.: *Just Horses*, The Macmillan Company, New York, 1930.

Eipper, P.: *Animal Children*, The Viking Press, Inc., New York, 1930.

Frasier, G. W., MacCracken, H. D., and Armstrong, L. G.: *We See*, The L. W. Singer Company, Inc., Syracuse, 1949.

Friskey, Margaret: *Johnny and the Monarch*, Children's Press, Inc., Chicago, 1946.

Hader, B., and Hader, E.: *Farmer in the Dell*, The Macmillan Company, New York, 1931.

—— and ——: *Lions and Tigers and Elephants, Too*, Longmans, Green & Co., Inc., New York, 1931.

——— and ———: *The Big Snow*, The Macmillan Company, New York, 1948.

Hall, William: *The Seven Little Elephants*, The Thomas Y. Crowell Company, New York, 1947.

Humphreys, Dena: *The Zoo Book*, Henry Holt and Company, Inc., New York, 1947.

Lord, I. E.: *The Picture Book of Animals*, The Macmillan Company, New York, 1932.

McKay, H.: *First Steps in Science*, Oxford University Press, New York, 1929.

Norling, Jo.: *Pogo's Lamb: A Story of Wool*, Henry Holt and Company, Inc., New York, 1947.

Palmer, Marion: *Walt Disney's Uncle Remus Stories* (Teacher's Story Book), Simon and Schuster, Inc., New York, 1947.

Patch, E. M.: *Holiday Meadow*, The Macmillan Company, New York, 1930.

Payne, Emmy: *Johnny Groundhog's Shadow*, Houghton Mifflin Company, Boston, 1948.

Payne, Frank: *One Hundred Lessons in Nature Study*, Beckley-Cardy Company, Chicago, 1923.

Purnell, I., and Weatherwax, J. M.: *The Talking Bird*, The Macmillan Company, New York, 1930.

Sterling, Helen: *The Horse That Takes the Milk Around*, David McKay Company, Philadelphia, 1946.

Villinger, Lou: *Children of Our Wilds*, Beckley-Cardy Company, Chicago, 1930.

Weil, Lisl.: *Bill the Brave*, Houghton Mifflin Company, Boston, 1948.

Selected Science Readers—Grade 2

Beatty, John Y.: *Farm Life Readers*, Beckley-Cardy Company, Chicago, 1940.

———: *Study Pictures of Farm Animals*, Beckley-Cardy Company, Chicago, 1940.

Black, Irma S.: *Maggie, A Mysterious Magpie*, Holiday House, Inc., New York, 1949.

Buckley, Horace: *In Storm and Sunshine*, American Book Company, New York, 1938.

Bush, Maybell: *Enjoying Our Land*, The Macmillan Company, New York, 1940.

Charters, W. W.: *Through the Year*, The Macmillan Company, New York, 1941.

Craig, Gerald S., and Burke, Agnes: *We Find Out*, Ginn & Company, Boston, 1940.

———, and Daniel, Etheleen: *Science through the Year*, Ginn & Company, Boston, 1946

English, M., and McCrory, Mae: *Wheels and Wings*, Johnson Publishing Company, Richmond, 1935.

Everhart, Frances: *How Animals Travel*, American Education Press, Columbus, 1935.

Faison, M. H.: *Scalawag, the Scottie*, American Book Company, New York, 1940.

Frasier, G. W., MacCracken, H. D., and Armstrong, L. G.: *Through the Year*, The L. W. Singer Company, Syracuse, 1949.

Freeland, Isabelle: *Animal Families*, American Education Press, Columbus, 1941.

Gates, Arthur I.: *Animals Are Fun*, The Macmillan Company, New York, 1940.

———: *Animals Work, Too*, The Macmillan Company, New York, 1940.

Gray, William S.: *Friends and Neighbors*, Scott, Foresman & Company, Chicago, 1941.

———: *More Friends and Neighbors*, Scott, Foresman & Company, Chicago, 1941.

Harris, Jennie: *Making Visits*, Book II, Houghton Mifflin Company, Boston, 1939.

Hawksworth, Hallam: *The Clever Little People with Six Legs*, Charles Scribner's Sons, New York, 1924.

Hildreth, Gertrude: *Along the Way*, John C. Winston Company, Philadelphia, 1940.

Horn, Ernest, and Shields, G. M.: *Making New Friends*, Ginn & Company, Boston, 1940.

Jones, E., Morgan, E., and Landis, P. E.: *My First Health Book*, Laidlaw Brothers, Inc., New York, 1950.

Knox, Warren W.: *Wonderworld of Science*, Books I–II, Charles Scribner's Sons, New York, 1940.

McDonough, R. D.: *Birds and Their Babies*, American Education Press, Columbus, 1941.

McReynolds, Bob: *Sleepy to the Rescue*, The Viking Press, Inc., New York, 1949.

Mitchell, Lucy S., and Brown, Margaret W.: *Animals, Plants and Machines*, D. C. Heath and Company, Boston, 1944.
Morcomb, Margaret E.: *Red Feather*, Lyons & Carnahan, Chicago, 1938.
Patch, Edith M.: *Outdoor Visits*, The Macmillan Company, New York, 1932.
Pennel, Mary E.: *Children's Own Reader*, Books I–II, Ginn & Company, Boston, 1936.
Studebaker, John Ward: *Number Stories*, Scott, Foresman & Company, Chicago, 1941.
Tatham, Campbell: *The First Book of Trains*, Franklin Watts, Inc., New York, 1948.
———: *The First Book of Automobiles*, Franklin Watts, Inc., New York, 1949.

Selected Science Readers—Grade 3

Beatty, John Y.: *The Farmer at His Work*, The Saalfield Publishing Company, Akron, 1933.
Bronson, Wilfred S.: *Fingerfins*, The Macmillan Company, New York, 1930.
———: *Paddlewings*, The Macmillan Company, New York, 1931.
———: *Pollwiggle's Progress*, The Macmillan Company, New 1945.
Buck, Margaret W.: *Animals throughout the Year*, Rand, McNally & Company, Chicago, 1941.
Buff, Mary, and Buff, Conrad: *Dash and Dart*, The Viking Press, Inc., New York, 1942.
——— and ———: *Kobi*, The Viking Press, Inc., New York, 1949.
Craig, Gerald S., and Baldwin, Sara: *Changes All around Us*, Ginn & Company, Boston, 1940.
——— and ———: *Science Every Day*, Ginn & Company, Boston, 1946.
Ditmars, Raymond L.: *Twenty Little Pets from Everywhere*, Julian Messner, Inc., Publishers, New York, 1943.
Editors of *Encyclopaedia Britannica: Animals of the Woods*, Encyclopaedia Britannica, Inc., Chicago, 1946.
———: *Black Bear Twins*, Encyclopaedia Britannica, Inc., Chicago, 1946
———: *Elephants*, Encyclopaedia Britannica, Inc., Chicago, 1946.

———: *Goats and Kids*, Encyclopaedia Britannica, Inc., Chicago, 1946.

———: *Gray Squirrel*, Encyclopaedia Britannica, Inc., Chicago, 1946.

———: *Snapping Turtle*, Encyclopaedia Britannica, Inc., Chicago, 1946.

———: *Water Birds*, Encyclopaedia Britannica, Inc., Chicago, 1946.

Emerson, Alfred E., and Fish, Eleanor: *Termite City*, Rand McNally & Company, Chicago, 1937.

Frasier, G. W., MacCracken, H. D., and Armstrong, L. G.: *Winter Comes and Goes*, The L. W. Singer Company, Inc., Syracuse, 1949.

Henry, Marguerite: *Birds at Home*, M. A. Donohue and Company, Chicago, 1942.

Huey, Edward G.: *A Child's Story of the Animal World*, Harcourt, Brace and Company, Inc., New York, 1935.

Huntington, Harriet E.: *Let's Go Outdoors*, Doubleday and Company, Inc., New York, 1939.

———: *Let's Go to the Seashore*, Doubleday and Company, Inc., New York, 1941.

Ipcar, Dahlov: *Animal Hide and Seek*, William R. Scott, Inc., New York, 1947.

Jones, E., Morgan, E., and Landis, P. E.: *My Second Health Book*, Laidlaw Brothers, Inc., New York, 1950.

Kaigh-Eustace, Edyth: *Jungle Babies*, Rand McNally & Company, Chicago, 1930.

Kane, Henry B.: *Tale of the Bullfrog*, Alfred A. Knopf, Inc., New York, 1941.

King, Eleanor, and Pessels, Wellmer: *Garden Creatures*, Harper & Brothers, New York, 1939.

King, Julius: *Peter and the Frog's Eye*, Grosset & Dunlap, Inc., New York, 1936.

Mellen, Ida M.: *Twenty Little Fishes*, Julian Messner, Inc., Publishers, New York, 1942.

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Animal Fair	Vocal (song)	Capitol 25012
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In a Bird Store (Lake)		
Jumbo's Lullaby (Debussy)		
Little White Donkey (Ibert)		
Monkeyshines around the Organ Grinder (Gary)		
Wedding of the Hen and the Cuckoo (Vicellinio)		
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Animals, Carnival of	Instrumental	Victor M 785
Arbor Day Song	Instrumental	Victor 20348
Autumn	Instrumental	Victor 20343
Autumn Song	Instrumental	Victor 11-9022
Baltimore Oriole	Vocal (whistling)	Decca 29216
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Bee and the Butterfly	Instrumental	Victor 20348
Blackbird	Actual sounds	Columbia YB19
Bozo under the Sea	Vocal (story)	Capitol Album DXB-99
Br'er Rabbit and the Tar Baby	Vocal (story)	Victor Y328
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Ivy Leaf	Instrumental	Decca 12098
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Rose, The	Instrumental	Victor 20343
Sheep Are Coming down the Road	Vocal (song)	Decca 24224
Shell, The	Instrumental	Victor 20348
Sly Mongoose	Vocal (story)	Decca 48058
Snow, Goose, The	Vocal (story)	Decca DA 386
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Spring Song	Instrumental	Victor 20343
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Storm at Sea	Actual sounds	Columbia YB 7
Stream, Down the	Choral song	Victor 25307
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Turtle Dove	Vocal (song)	Decca 23965
Uncle Remus Stories	Vocal narration with sound	Decca A 250
What Makes Rain	Vocal (story)	Decca CU 107

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All Pets, All Pets Magazine, 440 West Kalamazoo Ave., Kalamazoo 11, Mich.

American Childhood, Milton Bradley Company, 74 Park St., Springfield 2, Mass.

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Milton Bradley Company, 74 Park St., Springfield 2, Mass.
Modern School Supply Company, Goshen, Ind.
Palfreys' School Supply Company, 313 West Garvey Blvd., San Gabriel, Calif.
Plymouth Press, 2921 West 63d St., Chicago 29.
Rand-McNally Company, 536 South Clark St., Chicago 5.

SUPPLIES AND APPARATUS FOR DEPARTMENTALIZED SCIENCE

American Instrument Company, 8010 Georgia Ave., Silver Spring, Md.

American Optical Company, Scientific Instrument Division (Spencer), Buffalo 15, N.Y.

Bausch and Lomb Optical Company, 780L St. Paul St., Rochester 2, N.Y.

Braun Corporation, 2260 East 15th St., Los Angeles 21.

Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N.Y.

R. P. Cargille (transparent boxes), 118 Liberty St., New York 6.

Carolina Biological Supply Company, Elon College, N.C.

Central Scientific Company, 1700 Irving Park Rd., Chicago 13.

Central Scientific Company of California, Pacific Laboratory Division, 3555 Whittier Blvd., Los Angeles 23; Redman Division, 16 Beale St., San Francisco 5.

Clay-Adams Company, 141 East 25th St., New York 10.

College Biological Supply Company, 9230 Woodlawn Ave., Seattle 3, Wash.

Corning Glass Works, Laboratory Sales Department (glassware), Corning, N. Y.

Denoyer-Geppert Company, 5235 Ravenswood Ave., Chicago 40.

Eastman Kodak Company, 343 State St., Rochester 4, N.Y.

Eimer and Amend Company, Greenwich and Morton Sts., New York 14.

Fisher Scientific Supply Company, 717 Forbes St., Pittsburgh 19.

Galigher Company, Inc. (microscopic slides only), P.O. Box 63, Albany Station, Berkeley, Calif.

General Biological Supply House, 761–763 East 69th Pl., Chicago 37.

Harry Ross, Scientific Apparatus, 70 West Broadway, New York 7.

Harshaw Scientific Division, The Harshaw Chemical Company, 1945 East 97th St., Cleveland 6.

Harvard Apparatus Company (physiological), Dover, Mass.

E. Machlett and Son, 220 East 23d St., New York 10.

National Biological Supply Company, 4836 Foster Ave., Chicago, 30.

Oregon Biological Supply Company, 303 N.E. Multnomah St., Portland 12, Ore.

Radioactive Products, Incorporated, 3201 East Woodbridge St., Detroit 7.

Ross Allen's Reptile Institute, Silver Springs, Fla.

Schaar and Company, 754 West Lexington St., Chicago 7.

Standard Scientific Supply Corporation, 34 West 4th St., New York 12.

Testa Manufacturing Company (microscopes), 418 South Pecan St., Los Angeles 33.

Arthur H. Thomas Company, West Washington Sq., Philadelphia 5.

Triarch Botanical Products (George H. Conant), Ripon, Wis.

Universal Scientific Company, Inc., Vincennes, Ind.

Ward's Natural Science Establishment, 3000 Ridge Road East, Rochester 9, N.Y.

W. M. Welch Scientific Company, 1515 Sedgwick St., Chicago 10.

Windsor Biology Gardens, 316 West 3d St., Bloomington, Ind.

INDEX

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